ISO 9001:2015 AICTE-CII: GOLD Category Institute NAAC-'A' Grade Institute (CGPA: 3.19) NIRF-2025 Rank Band : 201-300

KAKATIYA INSTITUTE OF TECHNOLOGY & SCIENCE
Opp : Yerragattu Gutta, Hasanparthy (Mandal), WARANGAL - 506 015, TELANGANA, INDIA
काकतीय प्रौद्योगिकी एवं विज्ञान संस्थान, वरंगल - ५०६०१५, तेलंगाना, भारत
కాకతీయ సాంకేతిక విజ్ఞాన శాస్త్ర విద్యాలయం, వరంగల్ - ౫౦౬ ౦౧౫ తెలంగాణ, భారతదేశము
(An Autonomous Institute under Kakatiya University, Warangal)
(Approved by AICTE, New Delhi; Recognised by UGC under 2(f) & 12(B); Sponsored by EKASILA EDUCATION SOCIETY)

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DEPARTMENT OF MECHANICAL ENGINEERING

B. Tech (ME)

URR24-R25-CURRICULUM

I Sem to VIII Sem

Scheme of Instructions & Evaluation (SoIE)

B. Tech (ME) – CURRICULUM (KITSW-URR24-R25)

Abbreviations

L	Lecture Hour	O	Outside the Class Work (Self-Study) Hours
T	Tutorial Hour	E	Total Engagement in Hours
P	Practical Hour	C	Credit Assigned

I SEMESTER

Stream - II

Sl. No.	Category	Course Code	Course Title	Lectures / week					Credits
				L	T	P	O	E	C
-	**IKSC**	**U24IK100**	**AICTE Mandated Student Induction Programme (Universal Human Values - I)**						-
1	BSC	U24MH101	Differential Calculus and Ordinary Differential Equations	2	1	-	6	9	3
2	BSC	U24CY102A	Engineering Chemistry	2	1	2	5	10	4
3	PCC	U24ME103	Thermodynamics	2	1	-	4	7	3
4	ESC	U24ME104	Programming for Problem Solving with C	2	1	2	5	10	4
5	HSMC	U24MH105	English Communication and Report Writing	2	-	-	3	5	2
6	VAC	U24VA106	Sports & Yoga	-	-	2	2	4	1
7	ESC	U24ME107	Engineering Graphics & CAD	1	-	4	4	9	3
8	ELC	U24EL108	Practicum-I	-	-	-	4	4	1
9	VAC	U24VA109	SEA – I / SAA-I	-	-	-	2	2	1
10	AEC	U24AE110	Expert Talk Series-1	-	-	-	1	1	1
Total:				**11**	**4**	**10**	**36**	**61**	**23**
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)									

Pool – III (Chemistry)		
Sr. No.	**Course Code**	**Course Title**
1.	U24CY102A	Engineering Chemistry *(for Mechanical Engineering)*
2.	U24CY102B	Engineering Chemistry *(Common to CSM, CSD, CSN, CSO & IT)*

Stream-II

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	BSC	U24MH201	Matrix Theory and Vector Calculus	2	1	-	3	3
2	BSC	U24PY202A	Engineering Physics	2	1		3	3
3	PCC	U24ME203	Engineering Materials and Metallurgy	2	1	-	3	3
4	ESC	U24ME204	Data Structures through C	2	1		3	3
5	ESC	U24EE205A	Basic Electrical & Electronics Engineering from Pool - II	2	1		3	3
6	VAC	U24CY206	Environmental Studies	2	-	-	2	1
7	AEC	U24AE207	IDEA Lab Makerspace	-	-	2	2	1
8	BSC	U24PY209A	Engineering Physics Laboratory	-	-	2	2	1
9	ESC	U24ME210	Data Structures through C Laboratory	-	-	2	2	1
10	ESC	U24EE211A	Basic Electrical & Electronics Engineering Laboratory	-	-	2	2	1
Total:				**12**	**5**	**10**	**25**	**20**
Summer / Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)								

Pool – I (Physics)		
Sr. No.	**Course Code**	**Course Title**
1.	U24PY202A	Engineering Physics *(for Mechanical Engineering)*
2.	U24PY202B	Engineering Physics *(Common to CSM, CSD, CSN, CSO & IT)*

Pool – II (Basic Electrical & Electronics Engineering)		
S. No.	**Course Code**	**Course Title**
1.	U24EE205A	Basic Electrical and Electronics Engineering *(for Mechanical Engineering)*
2.	U24EE205B	Basic Electrical Engineering *(Common to CSM, CSD, CSN, CSO & IT)*

Bridge Courses for exit:

Successful completion of two subjects (6-Credits) during 2-months internship at the institute
OR
Successful completion of two suitable skill based courses (external) to qualify for Certification

A. After First Year: (UG Certificate in ME)

(i) The candidate should pass any two of the following additional courses (ITI Level) during the 2-Months internship at institute

Exit Option to Qualify UG Certificate in ME: Any Two (02) Courses during the 2 - Months internship								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	PCC	U24ME212X	Internal Combustion Engines	**2**	**-**	**2**	**4**	**3**
2	PCC	U24ME213X	Machine Drawing & Modelling	**2**	**-**	**2**	**4**	**3**
3	PCC	U24ME214X	Basic Mechanical Engineering	**2**	**-**	**2**	**4**	**3**
4	PCC	U24ME215X	Any other course approved by BoS Chair and Dean AA	**2**	**-**	**2**	**4**	**3**

(OR)

(ii) Any two suitable skill based courses to qualify for Certification.

Exit Option to Qualify UG Certificate in ME: Any Two (02) Skill based Courses -:								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	SEC	U24SE212X	Certificate course in Product Design and Development (Offered by MSME CITD)	**-**	**-**	**6**	**6**	**3**
2	SEC	U24SE213X	Foundry men (NSQF)	**-**	**-**	**6**	**6**	**3**
3	SEC	U24SE214X	Mechanic Diesel (NSQF)	**-**	**-**	**6**	**6**	**3**
4	SEC	U24SE215X	Certificate Course in Product Design and Manufacturing (CITD)	**-**	**-**	**6**	**6**	**3**
5	SEC	U24SE216X	Any other skill based course approved by BoS Chair and Dean AA	**-**	**-**	**6**	**6**	**3**

III SEMESTER

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	BSC	U24MH301B	Applied Mathematics	2	1	-	3	3
2	PCC	U24ME302	Mechanics of Materials	2	1	-	3	3
3	PCC	U24ME303	Manufacturing Technology	2	1	-	3	3
4	PCC	U24ME304	Heat Power Engineering	2	1	-	3	3
5	ESC	U24ME305	Python Programming	2	1	-	3	3
6	VAC	U24VA306B	Soft and Interpersonal Skills Laboratory			2	2	1
7	PCC	U24ME307	Mechanics of Materials Laboratory			2	2	1
8	PCC	U24ME308	Manufacturing Technology Laboratory			2	2	1
9	ESC	U24ME309	Python Programming Laboratory			2	2	1
Total:				**10**	**5**	**08**	**23**	**19**
Additional Learning@:Maximum credits allowed for Honours/Minor				-	-	-	-	05
Total credits for Honours/Minor students:				-	-	-	-	**25**
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)				**-**	**-**	**-**	**-**	**-**

*** Branch Specific Mathematics:**

Branch Specific Mathematics (Pool-IV)		
S. No.	**Course Code**	**Course Title**
1.	U24MH301A	Numerical and Statistical Methods ***(for Civil Engineering)***
2.	U24MH301B	Applied Mathematics ***(for Mechanical Engineering)***
3.	U24MH301C	Mathematical foundations for Signal Processing ***(for ECI)***
4.	U24MH301D	Discrete Mathematics and Probability Statistics ***(Common to CSE, CSN, CSO & IT)***
5.	U24MH301E	Essential Mathematics and Statistics for Machine learning ***(for CSM)***
6.	U24MH301F	Essential Mathematics and Statistics for Data science ***(for CSD)***

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	PCC	U24ME401	Heat Transfer	2	1	-	3	3
2	PCC	U24ME402	Machine Drawing	3	-	2	4	4
3	PCC	U24ME403	Fluid Mechanics and Hydraulic Machines	2	1	-	3	3
4	PCC	U24ME404	Design of Machine Elements	2	1	-	3	3
5	PCC	U24ME405	Machine Tools and Metrology	2	1	-	3	3
6	SEC	U24SE406	Programming Skill Development Laboratory	-	-	2	2	1
7	PCC	U24ME407	Modelling Laboratory	-	-	2	2	1
8	PCC	U24ME408	Fluid Mechanics and Hydraulic Machines Laboratory	-	-	2	2	1
9	PCC	U24ME409	Machine Tools and Metrology Laboratory	-	-	2	2	1
10	VAC*	U24CY411*	Environmental Studies*	2*	-	-	2*	1*
Total:				**11**	**4**	**10**	**24**	**20**
Additional Learning@: Maximum credits allowed for Honours/Minor				-	-	-	-	05
Total credits for Honours/Minor students:				-	-	-	-	25
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)				**-**	**-**	**-**	**-**	**-**

**For Lateral Entry Students Only*

Bridge Courses for exit:

Successful completion of two subjects (6-Credits) during 2-months internship at the institute

OR

Successful completion of two suitable skill based courses (external) to qualify for Certification

B. After Second Year: (UG Diploma in ME)

(i) The candidate should pass any two of the following additional courses (Diploma Level) during the 2-Months internship at institute

Exit Option to Qualify UG Diploma in ME: Any Two (02) Courses during the 2 - Months internship								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	PCC	U24ME412X	Theory of Machines	**2**	**-**	**2**	**4**	**3**
2	PCC	U24ME413X	Workshop Technology	**2**	**-**	**2**	**4**	**3**
3	PCC	U24ME414X	Refrigeration Systems	**2**	**-**	**2**	**4**	**3**
4	PCC	U24ME415X	Any other course approved by BoS Chair and Dean AA	**2**	**-**	**2**	**4**	**3**

(OR)

(ii) Any two suitable skill based courses to qualify for Diploma.

Exit Option to Qualify UG Diploma in ME: Any Two (02) Skill based Courses -:								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	SEC	U24SE412X	Certificate Course in Product Design and Analysis (Offered by MSME-CITD)	**-**	**-**	**6**	**6**	**3**
2	SEC	U24SE413X	Certificate Course in Design Of Plastic Injection Moulds (CITD)	**-**	**-**	**6**	**6**	**3**
3	SEC	U24SE414X	Certificate Course in Design of Press Tools (CITD)	**-**	**-**	**6**	**6**	**3**
4	SEC	U24SE415X	Mechanic Motor Vehicle (NSQF)	**-**	**-**	**6**	**6**	**3**
5	SEC	U24SE416X	Any other skill based course approved by BoS Chair and Dean AA	**-**	**-**	**6**	**6**	**3**

B. Tech Honours with Research:

- **Students opting for B. Tech Honours with Research, shall undergo a 2-Month Mandatory Research Internship-I (5 Credits) at respective department during the summer vacation after IV Semester.**

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	OE	U24OE501X	Open Elective-Sustainable Development Goals Basket (OE-SDG)	2	1	-	3	3
2	PCC	U24ME502	Refrigeration & Air Conditioning	2	1	-	3	3
3	PCC	U24ME503	Kinematics of Machinery	2	1	-	3	3
4	PCC	U24ME504	Artificial Intelligence and Machine Learning	2	1	-	3	3
5	PCC	U24ME505	Sustainable Energy Technology	2	1	-	3	3
6	IKSC	U24IK506B	Essence of Indian Traditional Knowledge	2	-	-	2	2
7	PCC	U24ME507	Theory of Machines Laboratory	-	-	2	2	1
8	PCC	U24ME508	Thermal Engineering Laboratory	-	-	2	2	1
9	PCC	U24ME509	AIML Applications Laboratory	-	-	2	2	1
10	ELC	U24ME510	Seminar	-	-	2	2	1
Total:				**12**	**5**	**8**	**25**	**21**
Additional Learning@:Maximum credits allowed for Honors/Minor				**-**	**-**	**-**	**-**	**05**
Total credits for Honors/Minor students:				**-**	**-**	**-**	**-**	**26**
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)				**-**	**-**	**-**	**-**	**-**

#MULTIDISCIPLINARY OPEN ELECTIVES: Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

@List of courses for additional learning through MOOCs towards Honors/Minor in Engineering shall be prescribed by the department under Honors/ Minor Curricula

Sustainable Development Goals Basket		
Sr. No.	**Course Code**	**Course Title**
1.	U24OE501A	Sustainable Waste Management and Circular Economy (Offered by CE Department)
2.	U24OE501B	Carbon Reduction and Net Zero (Offered by EEE Department)
3.	U24OE501F	Intelligent Imaging for Sustainable Engineering (Offered by ECE Department)
4.	U24OE501L	Sensors and Actuators for Sustainable Smart cities and Health care (Offered by ECI Department)
5.	U24OE501T	Object Oriented Programming through Java (Offered by IT Department)

Indian Knowledge System Courses (IKSC)		
Sr. No.	**Course Code**	**Course Title**
1.	U24IK506A	Universal Human Values-II
2.	U24IK506B	Essence of Indian Traditional Knowledge

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	OE	U24OE601X	Startups & Entrepreneurship Basket	2	1	-	3	3
2	PCC	U24ME602	Design of Transmission Systems	2	1	-	3	3
3	PCC	U24ME603	Machining Science	2	1	-	3	3
4	PCC	U24ME604	Dynamics of Machinery	2	1	-	3	3
5	PCC	U24ME605	Computational Fluid Dynamics	2	1	-	3	3
6	IKSC	U24IK606A	Universal Human Values-II	2	-	-	2	2
7	PCC	U24ME607	Production Engineering Laboratory	-	-	2	2	1
8	PCC	U24ME608	Computational Fluid Dynamics Laboratory	-	-	2	2	1
9	HSMC	U24MH609	Technical English	-	-	2	2	1
10	ELC	U24ME610	Mini Project	-	-	2	2	1
Total:				**12**	**5**	**8**	**25**	**21**
Additional Learning@: Maximum credits allowed for Honors/Minor				**-**	**-**	**-**	**-**	**05**
Total credits for Honors/Minor students:				**-**	**-**	**-**	**-**	**26**
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)				**-**	**-**	**-**	**-**	**-**

#MULTIDISCIPLINARY OPEN ELECTIVES: Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

@List of courses for additional learning through MOOCs towards Honors/Minor in Engineering shall be prescribed by the department under Honors/ Minor Curricula

B. Tech Honors with Research:

Students opting for B. Tech Honors with Research, shall undergo a 2-Month Mandatory Research Internship-II (5 Credits) at respective department during the summer vacation after VI Semester.

Startups & Entrepreneurship Basket		
Sr. No.	**Course Code**	**Course Title**
1.	U24OE601A	Design Thinking
2.	U24OE601B	Innovative Product Design and Development
3.	U24OE601C	Entrepreneurship
4.	U24OE601D	Design Studio
5.	U24OE601E	Any other course approved by BoS Chair and Dean AA

Indian Knowledge System Courses (IKSC)		
Sr. No.	**Course Code**	**Course Title**
1.	U24IK606A	Universal Human Values-II
2.	U24IK606B	Essence of Indian Traditional Knowledge

Bridge Courses for exit:

Successful completion of two subjects (6-Credits) during 2-months internship at the institute

OR

Successful completion of two suitable skill based courses (external) to qualify for Certification

C. After Third Year:(B. Voc. in ME)

(i) The candidate should pass any two of the following additional courses (Degree Level) during the 2-Months internship at institute

Exit Option to Qualify B. Voc in ME: Any Two (02) Courses during the 2 - Months internship								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	PCC	U24ME610X	Industrial Robotics	**2**	**-**	**2**	**4**	**3**
2	PCC	U24ME611X	Computer Integrated Manufacturing	**2**	**-**	**2**	**4**	**3**
3	PCC	U24ME612X	Power Plant Engineering	**2**	**-**	**2**	**4**	**3**
4	PCC	U24ME613X	Any other course approved by BoS Chair and Dean AA	**2**	**-**	**2**	**4**	**3**

(OR)

(ii) Any two suitable skill based courses to qualify for. Voc in ME Degree.

Exit Option to Qualify B. Voc in ME: Any Two (02) Skill based Courses -:								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	SEC	U24SE614X	Certificate Course in Design and Analysis of Mechanical Systems using NX and SIMCENTER (Offered by: Centre of excellence by Digital Manufacturing and Automation, NIT, Warangal)	**-**	**-**	**6**	**6**	**3**
2	SEC	U24SE615X	Certificate Course in CNC Programming & Machining (CITD)	**-**	**-**	**6**	**6**	**3**
3	SEC	U24SE616X	Refrigeration and Air Conditioning Technician (NSQF)	**-**	**-**	**6**	**6**	**3**
4	SEC	U24SE617X	Certificate Course in Product Design and Development (CITD)	**-**	**-**	**6**	**6**	**3**
5	SEC	U24SE618X	Any other skill based course approved by BoS Chair and Dean AA	**-**	**-**	**6**	**6**	**3**

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	OE	U24OE701Y	Open Elective – Management Basket (OE-MB)	2	1	-	3	3
2	PEC	U24ME702	Program Elective - I/ MOOCs-I	2	1	-	3	3
3	PCC	U24ME703	Finite Element Methods	2	1	-	3	3
4	PCC	U24ME704	Additive Manufacturing	2	1	-	3	3
5	PCC	U24ME705	Production and Operations Management	2	1	-	3	3
6	PCC	U24ME706	FEM Laboratory	-	-	2	2	1
7	ELC	U24ME707	Internship Evaluation*	-	-	2	2	1
8	ELC	U24ME708	Major Project, Phase-1 / Industrial Internship - 1	-	-	8	8	4
Total:				**10**	**5**	**12**	**27**	**21**
Additional Learning@: Maximum credits allowed for Honors/Minor				**-**	**-**	**-**	**-**	**04**
Total credits for Honors/Minor students:				**-**	**-**	**-**	**-**	**25**

#MULTIDISCIPLINARY OPEN ELECTIVES: Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

@ List of courses for additional learning through MOOCs towards Honors/Minor in Engineering shall be prescribed by the department under Honors/ Minor Curricula

B. Tech Honors with Research

Students opting for B. Tech Honors with Research, shall complete Research Methodology Course (4 Credits) through MOOCS (OR) a workshop / FDP of not less than one week on "Research Methodologies" (4 Credits).

Internship Evaluation for the students opting B. Tech Honors with Research, will be done on the 2-Month Research internship-II.

Management Courses Basket		
Sr. No.	**Course Code**	**Course Title**
1.	U24OE701A	Management Economics and Accountancy
2.	U24OE701B	Finance for Engineers
3.	U24OE701C	Organizational Behaviour
4.	U24OE701D	E-Commerce and Digital Marketing
5.	U24OE701E	Any other course approved by BoS Chair and Dean AA

Program Elective - I/ MOOCs-I		
Sr. No.	**Course Code**	**Course Title**
1.	U24ME702A	Design of Thermal Equipment
2.	U24ME702B	Automobile Engineering
3.	U24ME702C	Modern Machining Processes
4.	U24ME702D	Industry 5.0
5.	U24ME702E	Any other course approved by BoS Chair and Dean AA

VIII SEMESTER

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	PEC	U24ME801	Program Elective - II / MOOCs-II	2	1	-	3	3
2	PEC	U24ME802	Program Elective - III / MOOCs-III	2	1	-	3	3
3	PEC	U24ME803	Program Elective - IV / MOOCs-IV	2	1	-	3	3
4	ELC	U24ME804	Major Project, Phase – 2 / Industrial Internship - 2	-	-	12	12	6
Total:				**6**	**3**	**12**	**21**	**15**
Additional Learning@:Maximum credits allowed for Honors/Minor				**-**	**-**	**-**	**-**	**04**
Total credits for Honors/Minor students:				**-**	**-**	**-**	**-**	**19**

#MULTIDISCIPLINARY OPEN ELECTIVES: Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

@ List of courses for additional learning through MOOCs towards Honors/Minor in Engineering shall be prescribed by the department under Honors/ Minor Curricula

B. Tech Honors with Research
Students opting for B. Tech Honors with Research shall Publish a research paper in reputed journal indexed by SCI / SCOPUS/Web of Science (4 Credits).

Program Elective – II/ MOOCs-II		
Sr. No.	**Course Code**	**Course Title**
1.	U24ME801A	Power Plant Engineering
2.	U24ME801B	Robotics
3.	U24ME801C	Digital Manufacturing
4.	U24ME801D	Jet Propulsion and Rocket Engineering
5.	U24ME801E	Any other course approved by BoS Chair and Dean AA
Program Elective - III/ MOOCs-III		
Sr. No.	**Course Code**	**Course Title**
1.	U24ME802A	Electric and Hybrid Vehicles
2.	U24ME802B	Composite Materials
3.	U24ME802C	Computer Integrated Manufacturing Systems
4.	U24ME802D	Geometrical Dimensioning and Tolerancing
5.	U24ME802E	Any other course approved by BoS Chair and Dean AA
Program Elective - IV/ MOOCs-IV		
Sr. No.	**Course Code**	**Course Title**
1.	U24ME803A	Energy Audit and Management
2.	U24ME803B	Product Design
3.	U24ME803C	Sustainability in Manufacturing
4.	U24ME803D	Industrial Management
5.	U24ME803E	Any other course approved by BoS Chair and Dean AA

SUMMARY

SEMESTER	I	II	III	IV	V	VI	VII	VIII	TOTAL
CREDITS	23	20	19	20	21	21	21	15	160

SUMMARY OF CURRICULUM COMPONENTS

S. No.	CATEGORY	COURSE COMPONENT	TOTAL COURSES	TOTAL CREDITS	CURRICULUM CONTENT (%OF CREDITS)
1	BSC	Basic Science Courses	06	17	10.625
2	ESC	Engineering Science Courses	08	19	11.875
3	PCC	Program Core Courses	32	75	46.875
4	PEC	Program Elective Courses	04	12	7.5
5	OEC	Open Elective Courses	03	09	5.625
6	HSMC	Humanity, Social Sciences and Management Courses	02	03	1.875
7	ELC	Experiential Learning Courses	06	14	8.75
8	VAC	Value Added Courses	04	04	2.5
9	AEC	Ability Enhancement Courses	02	02	1.25
10	IKSC	Indian Knowledge System Courses	02	04	2.5
11	SEC	Skill Enhancement Courses	01	01	0.625
		Total	**70**	**160**	**100**

Semester	Number of Courses / Number of Credits (*Course Category wise*)											
	BSC	**ESC**	**PCC**	**PEC**	**OEC**	**HSMC**	**ELC**	**VAC**	**AEC**	**IKSC**	**SEC**	**TOTAL**
I	2/7	2/7	1/3	-	-	1/2	1/1	2/2	1/1	-	-	10/23
II	3/7	4/8	1/3	-	-	-	-	1/1	1/1	-	-	10/20
III	1/3	2/4	5/11	-	-	-	-	1/1	-	-	-	9/19
IV	-	-	8/19	-	-	-	-	-	-	-	1/1	9/20
V	-	-	7/15	-	1/3	-	1/1	-	-	1/2	-	10/21
VI	-	-	6/14	-	1/3	1/1	1/1	-	-	1/2	-	10/21
VII	-	-	4/10	1/3	1/3	-	2/5	-	-	-	-	8/21
VIII	-	-	-	3/9	-	-	1/6	-	-	-	-	4/15
Total	**6/17**	**8/19**	**32/75**	**4/12**	**3/9**	**2/3**	**6/14**	**4/4**	**2/2**	**2/4**	**1/1**	**70/160**
% **Weightage of Course Category**	**10.625%** (17/160)	**11.875%** (19/160)	**46.875%** (75/160)	**7.5%** (12/160)	**5.625%** (9/160)	**1.875%** (3/160)	**8.75%** (14/160)	**2.5%** (4/160)	**1.25%** (2/160)	**2.5%** (4/160)	**0.625%** (1/160)	**100 %** (160/160)

* Seminar- 1 C , Mini Project- 1 C, Intership Evalution-1 C, Major Project : 4+6

I SEMESTER

Stream - II

Sl. No.	Category	Course Code	Course Title	Lectures / week					Credits
				L	T	P	O	E	C
-	**IKSC**	**U24IK100**	**AICTE Mandated Student Induction Programme (Universal Human Values - I)**						-
1	BSC	U24MH101	Differential Calculus and Ordinary Differential Equations	2	1	-	6	9	3
2	BSC	U24CY102A	Engineering Chemistry	2	1	2	5	10	4
3	PCC	U24ME103	Thermodynamics	2	1	-	4	7	3
4	ESC	U24ME104	Programming for Problem Solving with C	2	1	2	5	10	4
5	HSMC	U24MH105	English Communication and Report Writing	2	-	-	3	5	2
6	VAC	U24VA106	Sports & Yoga	-	-	2	2	4	1
7	ESC	U24ME107	Engineering Graphics & CAD	1	-	4	4	9	3
8	ELC	U24EL108	Practicum-I	-	-	-	4	4	1
9	VAC	U24VA109	SEA – I / SAA-I	-	-	-	2	2	1
10	AEC	U24AE110	Expert Talk Series-1	-	-	-	1	1	1
			Total:	**11**	**4**	**10**	**36**	**61**	**23**
			Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)						

Pool – III (Chemistry)		
Sr. No.	**Course Code**	**Course Title**
1.	U24CY102A	Engineering Chemistry *(for Mechanical Engineering)*
2.	U24CY102B	Engineering Chemistry *(Common to CSM, CSD, CSN, CSO & IT)*

DIFFERENTIAL CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS			
Class: B. Tech. I -Semester		**Branch:** Common to all branches	
Course Code:	**U24MH101**	**Credits:**	**3**
Hours/Week (L-T-P-O-E):	**2-1-0-6-9**	**CIE:**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: convergence of an infinite series and differential calculus
LO2: partial differentiation and its applications
LO3: differential equations of first order and first degree along with certain applications
LO4: higher order linear differential equations and applications

UNIT-I	**9 Hrs**

Infinite Series: Sequences, Series, General properties of series, Series of positive terms, Comparison tests-Limit form, Integral test, D'Alembert's Ratio test, Cauchy's root test

Differential Calculus and its applications: Fundamental theorems-Rolle's theorem (Geometrical interpretation), Lagrange's mean value theorem (Geometrical interpretation), Cauchy's mean value theorem, Taylor's theorem (Generalized mean value theorem), Expansions of functions- Maclaurin's series, Taylor's series, Maxima and Minima-Conditions, Practical problems (rectangle, right circular cylinder, cone)

Self-Learning Topics (SLTs): *Review of basic concepts of limit, continuity and differentiability [Reference 1: topic (3.1,3.2,3.5,4.1)]*
Alternating series [(Text 1: topic 9.12, Solved problems: 9.16,9.17 Practice problems: exercise 9.7 (1, 7)]
Additional problems on fundamental theorems [(Text 1: topic 4.3, Solved problems: 4.13(i),4.14,4.17, Practice problems: exercise 4.4 (1(i),1(ii), 3(ii), 10(i), 10(ii))]
Additional problems on Maclaurin's series [(Text 1: topic 4.4, Solved problems: 4.20, Practice problems: exercise 4.5 (3, 5)]

UNIT-II	**9 Hrs**

Partial differentiation and its applications: Functions of two or more variables, Partial derivatives, Total derivative, Change of variables, Jacobians, Functional relationship, Geometrical Interpretation-Tangentplane and Normal to a surface, Taylor's theorem for function of two variables (without proof), Errors and approximations, Total differential, Maxima and minima of functions of two variables, Lagrange's method of undetermined multipliers, Differentiation under the integral sign

Self-Learning Topics (SLTs):
Leibnitz rule of Differentiation under the integral sign for variable limits [(Text 1: topic 5.13(2)), Solved problems: 5.54, Practice problems: exercise 5.11 (1)]
Additional problems on maxima and minima of function of two variables [(Text 1: topic 5.11 (1), Solved problems: 5.42, 5.43, Practice problems: exercise 5.10 (1(i),1(ii),1(iii))].
Additional problems on Lagrange's methods of undetermined multipliers [(Text 1: topic (5.12), Solved problems: 5.45, 5.48, Practice problems: exercise 5.10 (3(i) ,3(ii))]

UNIT-III	**9 Hrs**

Differential equations of first order (DE): Reorientation of differential equation of first order and first degree (Formation a differential equation, variables separable method, homogeneous equations, Linear equations), Exact differential equations, Equations reducible to exact equations,

Applications of differential equations of first order: Orthogonal trajectories - Orthogonal

trajectories of the family of curves f(x, y, c)=0, Physical applications-Motion of a boat across a stream, Resisted motion, Velocity of escape from the earth, Simple electric circuits - RL series circuit, Newton's law of cooling, Rate of decay of Radio-active materials, Rate of growth of population

Self-Learning Topics (SLTs): *Review of DEs of first order (Text 1: topic 11.1, 11.2, 11.3, 11.4,11.5)*
Solutions of Non-exact DEs by Inspection Method [(Text 1: topic 11.12(1), Solved Problems: 11.30, Practice problems: exercise 11.8 (1,3)]
Additional problems on Non-exact DEs [(Text 1: topic 11.12(2,3,4,5), Solved problems: 11.33,11.35,11.36, Practice problems: exercise 11.8 (9,15)]
Orthogonal Trajectories of family of curves in polar coordinates [(Text 1: topic 12.3(3), Solved problems :12.7,12.8 , Practice problems: exercise 12.2(9,10)]

UNIT-IV	**9 Hrs**

Linear differential equations: Linear differential equations with constant coefficients, Rules for finding complementary function, Inverse operator, Rules for finding the particular integral ($Q=e^{ax}$, sin(ax+b) or cos(ax+b), x^m and $e^{ax}V(x)$), Method of variation of parameters, Linear dependence of solutions
Applications of linear differential equations: Simple harmonic motion, Simple pendulum, Oscillations of spring, Oscillatory electrical circuit-LCR circuit, Electro-mechanical analog

Self-Learning Topics (SLTs):
Finding the particular integral of $Q(X) = X^m V(X)$ *[(Text 1: topic 13.7, Solved problems: 13.16,13.17,13.19, Practice problems: exercise 13.2 (21,22)].*
Additional problems on method of variation of parameters [(Text 1: topic 13.8(1), Solved problems: 13.25, 13.26, Practice problems: exercise 13.3(1,5)]
Cauchy's homogeneous linear differential equation [(Text 1: topic 13.9(1), Solved problems: 13.31,13.34, Practice problems: exercise 13.4(3,6,9)]

Course Learning Outcomes (COs):
After completion of this course, the students should be able to…
CO1: examine the convergence of a series and interpret mean value theorems.
CO2: apply partial differentiation to functions of several variables in solving various engineering problems.
CO3: apply appropriate methods of differential equations of first order and first degree to solve real life engineering problems.
CO4:analyze the solutions of higher order linear differential equation with constant coefficients

Textbook(s):
1. Grewal, B.S., *Higher Engineering Mathematics*, 44th ed., Delhi: Khanna Publishers, 2017

Reference Book(s):
1. Shanti Narayan, Dr. Mittal P.K, *Differential Calculus*, 1st ed., Reprint New Delhi: S. Chand & Co., 2014
2. Kreyszig E, *Advanced Engineering Mathematics*, Inc, 10th ed., U.K: John wiely & sons, 2020
3. S.S. Sastry, *Engineering Mathematics*, Vol.II, 3rd ed., Prentice Hall of India, 2014.

Web and Video link(s):
1. https://youtu.be/4EYko9rdF7g?si=WUu12 *NPTEL Video Lecture on Infinite series by Prof. S.K.Ray, Professor of Mathematics, IITK Kanpur.*

2. https://youtu.be/0apMXhWG_W8?si=M-abw2Gq3buX5HLM *NPTEL Video Lecture on Fundamental mean value theorems by Prof. Jithedra Kumar, Professor of Mathematics, IITK Kharagpur.*
3. https://youtu.be/6r5jfT8xrXM?si=ryLXYVJr4-iUkdlV; *NPTEL Video Lecture on Exact Differential Equations, Prof. Jithedra Kumar, Professor of Mathematics, IIT Kharagpur.*
4. https://youtu.be/kbGhrqV9AOM?si=yGyK_V7kJKGa3OaR *NPTEL Video Lecture on Orthogonal Trajectories of family of curves by Prof. Aditya Sharma, Professor of Physics, IISE Bhopal.*
5. *https://youtu.be/btOCUmJkrrg?si=zq3nB00kplm7b5se*; *NPTEL Video Lecture on Higher Order Linear Differential Equations, Prof. Jithedra Kumar, Professor of Mathematics, IIT Kharagpur.*

Course Articulation Matrix (CAM):		**U24MH101 DIFFERENTIAL CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS**											
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24MH101.1**	2	2	1	1	-	-	-	1	1	-	1	1	1
CO2	**U24MH101.2**	2	2	1	1	-	-	-	1	1	-	1	1	1
CO3	**U24MH101.3**	2	2	1	1	-	-	-	1	1	-	1	1	1
CO4	**U24MH101.4**	2	2	1	1	-	-	-	1	1	-	1	1	1
U24MH101		**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**-**	**1**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

ENGINEERING CHEMISTRY (*for Mechanical Engineering*)

Class: B.Tech. I-Semester		**Branch:** ME	
Course Code:	**U24CY102A**	**Credits:**	**4**
Hours/Week (L-T-P-O-E):	**2-1-2-5-10**	**CIE:**	**60%**
Total Number of Teaching Hours:	**60 Hrs**	**ESE:**	**40%**

Course Learning Objectives (LOs):
This course will develop students' knowledge in /on…
LO1: electrochemical energy systems, batteries and fuel cells
LO2: water analysis and corrosion with its preventive methods
LO3: ferrous, non-ferrous, super alloys and polymers
LO4: lubricants, combustion, chemistry of carbon and hydrogen

THEORY COMPONENT

UNIT-I	**9 Hrs**

Electrochemical Energy Systems: Specific conductance, Equivalent conductance, Effect of dilution; Conductometric titrations-Acid base titrations-Strong acid vs strong base, Strong acid vs weak base, Weak acid vs strong base, Weak acid vs weak base; Advantages of conductometric titrations; Galvanic cell, Electrode potential, Electro motive force, Nernst equation; Potentiometric titrations-Acid base titrations, advantages; Biosensors
Batteries: Classification of batteries, Construction, Working principle, Advantages, Disadvantages and applications of Lead-acid battery and Li-ion battery
Self Learning Topics (SLTs): *Types of conductors (Text1: chapter 5 topic 1), Ohms law (Text1: chapter 5 topic 5), Commercial cells (Text1: chapter 6 topic 12)*

UNIT-II	**9 Hrs**

Water Analysis and Treatment: Hardness of water, Determination of hardness of water by using EDTA, Determination of alkalinity, Determination of fluoride by spectrophotometry, Determination of dissolved oxygen, Biochemical oxygen demand, Chemical oxygen demand, Softening of water-ion exchange process, Desalination of brackish water, Reverse osmosis, Electro dialysis
Corrosion: Introduction, Corrosion by pure chemical reaction (Dry corrosion), Electrochemical corrosion (Wet corrosion); Factors influencing corrosion; Prevention methods of corrosion-Cathodic protection; Electroplating
Self Learning Topics (SLTs): *Units of hardness (Text1: chapter 1 topic: 5), Introduction to corrosion (Text1: chapter 7 topic: 1)*

UNIT-III	**9 Hrs**

Ferrous Metals and Alloys: Types of steels, Types of cast irons, Effect of common alloying elements on plain carbon steels
Non-Ferrous Metals and Alloys: Composition, Properties, Applications of aluminium and its alloys, Copper and its alloys, Titanium and its alloys
Super Alloys: Importance, Classification, Titanium based, Nickel based, Cobalt based [Inconel 718, Ti-6 Al-4v], Chemical composition, Properties and applications
Polymers: Introduction, Classification of polymers-Natural and synthetic polymers; Thermoplastic and thermosetting polymers; Functionality, Molecular weight of polymers, Plastics, Rubbers (Elastomers), Liquid Silicone Rubber (LSR), Fibers, Properties of polymers, Degradation of polymer, Polymer composites

Self Learning Topics (SLTs): *Types of metal alloys (Text2: chapter 11 topic 11), Nomenclature of polymers (Text1: chapter 3 topics: 2,3)*

UNIT-IV	**9 Hrs**

Fuels: Properties of solid, liquid and gaseous fuels; Flash and fire points, Viscosity measurement–Redwood and Saybolt viscometer; Measurement of calorific value, Exploration of crude petroleum, Evaluation of crude, Distillation; Characteristics of fuels for internal combustion engines-Knocking, Octane number, Cetane number; Compressed natural gas (CNG), Liquefied Natural Gas (LPG), Power alcohol and Biodiesel

Combustion: Stoichiometric air-fuel ratio, Air-fuel ratio from analysis of products of combustion, Conversion of volumetric analysis to mass analysis and vice versa, Mass of dry flue gases per kg of fuel burnt, Mass of excess air supplied

Wear and Lubrication: Types of wear, Lubricants, Types, Properties and functions

Chemistry of Carbon and Hydrogen: Hydrogen-industrial method of preparation, Properties, Storage, Applications, Carbon - isotopes, Allotrope, Chemical properties and uses.

Self Learning Topics (SLTs): *Introduction and classification of fuels (Text1: chapter 2 topics 1,2), Comparison of diesel fuel and gasoline fuel (Text1: chapter 2 topic 18, table 5)*

LABORATORY COMPONENT

List of Experiments

1. Estimation of hydroxide ion [OH^-] by acidimetry using standard sodium carbonate solution
2. Estimation of alkalinity of water sample containing (i) carbonate (ii) carbonate & bicarbonate in ground water
3. Estimation of alkalinity of water sample containing (i) bi carbonate (ii) carbonate & hydroxide in potable water
4. Standardization of sodium hydroxide (NaOH) by conductometry using standard hydrochloric acid (HCl)
5. Standardization of acetic acid (CH_3COOH) by conductometry using standard sodium hydroxide (NaOH)
6. Standardization of strong acid (HCl) by potentiometry using standard sodium hydroxide (NaOH)
7. Determination of hardness of water by complexometric method
8. Kinematic and dynamic viscosity measurement of a given fuel/lubricating oil using Redwood viscometer/Saybolt apparatus
9. Flash and fire points of a given fuel using Cleveland's/Abel's apparatus
10. Carbon residue of a given fuel using Rams bottom apparatus
11. a). Synthesis of polymer (phenol- formaldehyde)
    b). Fabrication of polymer composite using hand layup technique and evaluate the defects of fabrication
12. Determination of resistance to wear rate of polymer composite in accordance with ASTM D1242 using pin on disc test rig

Textbook(s):

1. Jain and Jain, *Engineering Chemistry*, 17th ed., Dhanpat Rai Publishing Company, 2019
2. William D. Callister Jr & David G. Rethwisch, *Material Science Engineering*, 10th ed., Wiley, 2018 (Chapter 11)

Reference Book(s):

1. S. Agarwal, *Engineering Chemistry Fundamentals and Applications*. Cambridge University Press, May 23, 2019
2. Rajesh K., Prasad, Ojha T. P., *Non-Conventional Energy Sources,* 4th ed., Jain Brothers, 2014 (Chapter 6)

Web and video link(s):

https://elearn.nptel.ac.in/shop/iit-workshops/completed/battery-cell-technology-materials-and-industrial-applications/?v=c86ee0d9d7ed ; *NPTEL video lecture on battery technology by Dr. Kothandaraman, Professor of Chemistry, IIT Madras & Dr. Raghunathan, Professor of Chemical engineering, IIT Madras*

Laboratory Manual (for laboratory component):

Engineering chemistry laboratory manual, Department of physical sciences/Chemistry, KITSW

Course Learning Outcomes (COs): Course Learning Outcomes (COs):
After completion of this course, the students should be able to,
(based on cognitive skills acquired from theory component)
CO1: apply the concepts of electrochemical energy systems in engineering practice
CO2: adapt the essential techniques of water analysis, treatment and corrosion & it's control.
CO3: appraise applications of ferrous, non-ferrous, super alloys and polymers
CO4: apply the knowledge of lubricants, combustion in the field of engineering
(based on psychomotor skills acquired from laboratory component)
CO5: determine water quality parameters - alkalinity, hardness
CO6: make use of analytical instruments for chemical analysis
CO7: measure viscosity, flash and fire point of a fuel
CO8: design synthesis of polymer

Course Articulation Matrix (CAM):		**U24CY102A ENGINEERING CHEMISTRY (*for Mechanical Engineering*)**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24CY102A.1**	2	-	-		1	1	1	-	1	-	1	1	1
CO2	**U24CY102A.2**	2	-	-	-	1	1	1		1	-	1	1	1
CO3	**U24CY102A.3**	2	1	-	-	-	1	1	-	1	-	1	1	1
CO4	**U24CY102A.4**	2	-	-	-	1	1	1	-	1	-	1	1	1
CO5	**U24CY102A.5**	2	1	-	-	-	1	1	-	1	-	1	1	1
CO6	**U24CY102A.6**	2	1	-	-	2	1	1	-	1	-	1	1	1
CO7	**U24CY102A.7**	2	1	-	-	2	1	2	1	1	-	1	1	1
CO8	**U24CY102A.8**	2	1	-	-	-	1	1	-	1	-	1	1	1
	U24CY102A	**2**	**1**	**-**	**-**	**1.4**	**1**	**1.13**	**1**	**1**	**-**	**1**	**1**	**1**

U24ME103 THERMODYNAMICS

Class: B.Tech. I -Semester		**Branch:** Mechanical Engineering (ME)	
Course Code:	**U24ME103**	**Credits:**	**3**
Hours/Week (L-T-P-O-E):	**2-1-0-4-7**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: concept of heat and work, and first law of thermodynamics applied to closed systems
LO2: steady flow energy equation, its applications and second law of thermodynamics
LO3: entropy for various processes, availability, irreversibility and second law efficiency
LO4: thermodynamic relations and gas turbines

UNIT-I	**9 Hrs**

Fundamental Concepts: Introduction, units, types of systems, control volume, control mass, continuum, macroscopic and microscopic point of view thermodynamics, Thermodynamic state, property, process, cycle, Intensive and extensive properties; Heat and Work, Thermodynamic Equilibrium, point and path functions, cyclic process, reversibility, quasi static process, irreversible process, Zeroth law of Thermodynamics and its applications

First Law of Thermodynamics to closed system: Statement of First law, applications to closed systems- internal energy, enthalpy and specific heats; Processes of closed system-constant volume, constant pressure, isothermal, adiabatic and polytrophic; P-V-T relations, Perfect and real gases, Joule-Thomson coefficient, inversion curve, Vander walls equation of state

Self Learning Topics (SLTs): *Macroscopic and Microscopic Viewpoint, Units and Dimensions, Measurement of Temperature, Other Types of Work Transfer, Different Forms of Stored Energy(Text1: topics 1.6, 1.15, 2.2, 3.4, 4.4), Practice problems (Text1: Prob 1.1, 1.5, 2.1,2.3, 3.4, 3.6, 4.2, 4.3 4.4)*

UNIT-II	**9 Hrs**

First law applied to open system: Steady flow energy equation (SFEE); applications to thermodynamic devices- boiler, turbine, nozzle, compressor, pump, heat exchangers

Second Law of Thermodynamics: Limitations of first law of thermodynamics, Kelvin Planck Statement, Clausius statement, Equivalence of Kelvin and Clausius Statements, Heat engine, Heat pump, Refrigerator, relation between COP of Heat pump and Refrigerator, Reversibility, Irreversibility, Causes of irreversibility, Conditions for reversibility, Carnot cycle, Carnot theorem, Thermodynamic temperature scales

Self Learning Topics (SLTs): *Steady flow Process involving two fluid streams at the inlet and exit (Text1: topics 5.3.1, 5.3.2), Solved problems (Text1: Prob 5.1, Prob 5.5, Prob 5.7), Irreversibility due to Lack of Equilibrium (Text1: topics 6.9.1), Solved problems (Text1: Prob 6.1, Prob 6.2, Prob 6.5)*

UNIT-III	**9 Hrs**

Entropy: Concept of Entropy, Clausius inequality, Entropy principle and its applications, property of entropy, entropy change in various processes, entropy change mechanism, entropy generation in open and closed system, Entropy and Disorder, Third law of Thermodynamics

Availability: Available energy, unavailable energy, Available energy referred to a cycle, irreversibility, second law efficiency, Helmholtz and Gibb's functions

Self Learning Topics (SLTs): *Processes exhibiting external mechanical irreversibility (Text1: topics 7.9.5), Solved problems (Text1: Prob 7.3, Prob 7.6, Prob 7.9)*

UNIT-IV	**9 Hrs**

Thermodynamic Relations: Max-well relations, coefficient of volume expansion, isothermal compressibility factor, T-ds Equations, difference in heat capacities, ratio of heat capacities, change in internal energy, entropy and enthalpy equations

Gas Turbines: Classification; comparison between open and closed cycle gas turbine; deviation of actual gas turbine cycle from Brayton Cycle-Isentropic efficiencies of compressor and gas turbine; methods of improving thermal efficiencies of gas turbine power plant - reheating, regeneration and inter cooling; applications

Self Learning Topics (SLTs): *Solved problems (Text1: Prob 11.1, Prob11.2, Prob 11.7) Solved problems (Text1: Prob 13.5, Prob13.7, Prob 13.8)*

Textbook(s):

1. Nag P.K., *Engineering Thermodynamics*, 6th ed., McGraw Hill Education, 2017.

Reference Book(s):

1. Vanwylen G.J. and Sonntag R.E., *Fundamentals of Thermodynamics*, 7th ed., Wiley India Pvt. Ltd., 2009.
2. Yonus A Cengel and Michale A Boles, *Thermodynamics: an Engineering Approach*, 9th ed., McGraw Hill Education, 2019.
3. Mahesh M Rathore, *Thermal Engineering*, McGraw Hill Education, 2010.
4. Ganesan V., *Gas Turbines*, 3rd ed., McGraw Hill Education, 2018.

Web and Video link(s):

1. https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8; N*PTEL Video Lecture on Basic Thermodynamics by Prof. S. K. Som, Professor of Mechanical Engineering, IIT Kharagpur.*
2. https://nptel.ac.in/courses/112102255; *NPTEL Video Lecture on Thermodynamics by Prof. S. R. Kale, Professor of Mechanical Engineering, IIT Delhi.*

Course Learning Outcomes (COs):

After completion of this course, the students should be able to.....

CO1: distinguish heat & work and determine energy transfer for a closed system

CO2: evaluate the performance of various thermodynamic devices by applying steady flow energy equation (SFEE) and second law of thermodynamics principles

CO3: estimate entropy change, availability, irreversibility and second law efficiency for various processes

CO4: analyze the thermodynamic relations and performance of a gas turbine power plant

Course Articulation Matrix (CAM):		**U24ME103**		**THERMODYNAMICS**									
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME103.1**	2	2	1	-	-	-	1	1	1	-	1	2	1
CO2	**U24MH103.2**	2	2	1	-	-	-	1	1	1	-	1	2	1
CO3	**U24MH103.3**	2	2	1	-	-	-	1	1	1	-	1	2	1
CO4	**U24MH103.4**	2	2	1	-	-	1	1	1	1	-	1	2	1
U24ME103		**2**	**2**	**1**	**-**	**-**	**1**	**1**	**1**	**1**	**-**	**1**	**2**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

PROGRAMMING FOR PROBLEM SOLVING WITH C

Class: B. Tech. I -Semester		**Branch:** Common to all branches	
Course Code:	**U24ME104**	**Credits:**	**4**
Hours/Week (L-T-P-O-E):	**2-1-2-5-10**	**CIE:**	**60%**
Total Number of Teaching Hours:	**60 Hrs**	**ESE:**	**40%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: algorithms, flow charts and develop programs with basic constructs

LO2: control structures and array operations

LO3: string operations and modular programming concepts with functions and recursion

LO4: structures, unions, pointers and files in C programming

THEORY COMPONENT

UNIT-I — **9 Hrs**

Introduction to Programming: Art of programming through algorithms and flowcharts

Overview of C: History of C, Importance of C, Basic structure of C programs

Constants, Variables and Data Types: Character set, C tokens, Declaration of variables, Defining symbolic constants

Managing Input and Output Operations: Reading a character, Writing a character**,** Formatted input, Formatted output

Operators and Expressions: Arithmetic, Relational, Increment, Decrement, Conditional, Logical, Bit-wise, Special operators, Arithmetic expressions, Evaluation of expressions, Operator precedence and associativity

Self Learning Topics (SLTs): *Components of a computer, concept of hardware and software (Text1: chapter 1), Executing a C program (Text1: chapter 2), Type conversions in expression (Text1: chapter 4) Solved problems (Text1: chapter 2 to chapter 5), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 2 to chapter 5)*

UNIT-II — **9 Hrs**

Decision Making and Branching: Simple if statement, if-else statement, Nesting of if-else statements, else if ladder, switch statement, Conditional operator, goto statement

Decision Making and Looping: while statement, do-while statement, for statement, Nested loops, Jumps in loops

Arrays: One-dimensional arrays, Declaration of one-dimensional arrays, Initialization of one-dimensional arrays, Linear search, Two-dimensional arrays, Initializing two dimensional arrays, Multi-dimensional arrays

Self Learning Topics (SLTs): *Concise test expressions (Text1: chapter 7) Dynamic arrays (Text1: chapter 8), Solved problems (Text1: chapter 6 to chapter 8), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 6 to chapter 8)*

UNIT-III — **9 Hrs**

Character Arrays and Strings: Declaring and initializing string variable, Reading strings from terminal, Writing strings to screen, String handling functions, Table of strings

Modular Programming with User Defined Functions: Need for user-defined functions, Elements of user-defined functions, Definition of functions, Return values and their types, Function calls, Function declaration, Category of functions, Recursion, The scope, visibility and lifetime of variables (storage classes)

Self Learning Topics (SLTs): *Arithmetic operations on characters, comparison of strings (Text1: chapter 9), Nesting of functions, (Text1: chapter 10), Solved problems (Text1: chapter 9 & chapter 10), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 9 & chapter 10).*

UNIT-IV — **9 Hrs**

Structures and Unions: Defining a structure, Declaring and initializing structure variables, Accessing structure members, Array of structures, Structures within structures, Unions

Pointers: Understanding pointers, Declaring and initializing pointer variables, Pointer expressions, Pointers and arrays, Pointers and character strings, Pointers to functions, Pointers and structures

File Management in C: Defining and opening a file, Closing a file, Input and output operations on sequential text files

Self Learning Topics (SLTs): *Operations on individual members (Text1: chapter 11), Chain of pointers, array of pointers (Text1: chapter 12), Random access to files, Command line arguments (Text1: chapter 13). Solved problems (Text1: chapter 11 to chapter 13), Review questions, debugging exercises, programming exercises, interview questions (Text1: chapter 11 to chapter 13).*

LABORATORY COMPONENT

List of Experiments

1. Programs using input output functions, operators (arithmetic, relational and conditional)
2. Programs using operators (bit-wise, logical, increment and decrement)
3. Programs using conditional control structures: if, if-else, nested if
4. Programs using else if ladder, switch and goto statements
5. Programs using loop control structures: while
6. Programs using loop control structures: do-while and for
7. Programs on one dimensional array and two-dimensional arrays
8. Programs on String operations and string handling functions
9. Programs on different types of functions, parameter passing using call-by-value & call-by-address, recursion and storage classes
10. Programs using structures, unions, pointers to arrays and pointers to strings
11. Programs using array of pointers and pointers to structures
12. Programs on File operations and file handling functions for sequential text files

Textbook(s):

1. Balagurusamy.E, *Programming in ANSI C*, 8th ed., McGraw Hill, 2022

Reference Book(s):

1. Paul Deitel, Harvey Deitel, *C How to Program: With Case Studies Introducing Applications Programming and Systems Programming*, 9th ed., Pearson Education Limited, 2022
2. Brian W. Kernighan and Dennis Ritchie, *The C Programming Language*, 2nd ed., Pearson Education India, 2015
3. Reema Thareja, *Programming in C,* 3rd ed., Oxford University Press, 2023
4. Yashavant Kanetkar, *Let Us C,* 19th ed., BPB Publications, 2022
5. A.K.Sharma, *Computer Fundamentals and Programming in C,* 2nd ed., Universities Press, 2018

Web and Video link(s):

1. https://nptel.ac.in/courses/106105171 *NPTEL Video Lecture on Problem Solving through Programming in C by Prof. Anupam Basu, Professor of CSE, IIT Kharagpur.*
2. https://nptel.ac.in/courses/106104128 *NPTEL Video Lecture on Introduction to Programming in C by Prof. Satyadev Nandakumar, Professor of CSE, IIT Kanpur*

Laboratory Manual (for laboratory component):

Programming for Problem Solving with C Laboratory Manual and Record Book, Department of CSE, KITSW.

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

(based on cognitive skills acquired from theory component)

CO1: enumerate programming development steps, design an algorithm and draw a flow chart for a given application

CO2: apply logical skills for problem solving using control structures and arrays

CO3: develop string operations and modular programming with functions

CO4: analyse and implement structures, unions, pointers and files in C programming

(based on psychomotor skills acquired from laboratory component)

CO5: develop programs using operators and decision making statements

CO6: apply loops and arrays to develop a program of an application

CO7: implement string operations and develop modular programs using user-defined functions, recursion, and storage classes.

CO8: develop programs using structures, unions, pointers and files

Course Articulation Matrix (CAM):		U24ME104: PRAGRAMMING FOR PROBLEM SOLVING WITH C												
CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	U24ME104.1	2	1	1	1	-	-	1	1	1	1	2	1	1
CO2	U24ME104.2	2	2	2	1	-	-	1	1	1	1	2	1	1
CO3	U24ME104.3	2	2	3	1	-	-	1	1	1	1	2	1	1
CO4	U24ME104.4	2	2	3	2	-	-	1	1	1	1	2	1	1
CO5	U24ME104.5	1	1	1	1	1	-	1	1	1	1	2	1	1
CO6	U24ME104.6	1	2	2	2	1	-	1	1	1	1	2	1	1
CO7	U24ME104.7	1	2	3	2	1	-	1	1	1	1	2	1	1
CO8	U24ME104.8	1	2	3	2	1	-	1	1	1	1	2	1	1
U24ME104		**1.5**	**1.75**	**2.25**	**1.5**	**1**	**-**	**1**	**1**	**1**	**1**	**2**	**1**	**1**

ENGLISH COMMUNICATION AND REPORT WRITING

Class: B. Tech. I –Semester		**Branch:** Common to all branches	
Course Code:	**U24MH105**	**Credits:**	**2**
Hours/Week (L-T-P-O-E):	**2-0-0-3-5**	**CIE:**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: basic grammar principles, reading speed, forming new words, making coherent paragraphs and also promoting ethical values for meaningful life.

LO2: speaking or writing correct sentences, writing effective letters and improving their self-worth.

LO3: critical reading ability, writing conclusive reports and additionally inculcating positive thinking.

LO4: abridging varieties of lengthy texts and maintaining emotional balance.

UNIT-I	**9Hrs**

GRAMMAR

- Tenses-Structures-usage-examples-exercises for practice
- Sentence Correction-Correct use of Tenses, Verb forms, Punctuation.

VOCABULARY

- Word formation: Prefixes-Suffixes-Sentence Formation with newly formed words

READING SKILL

- Definition-Sub skills of Reading-Emphasis on Skimming-Purpose- How to skim through the text-Examples, Exercises for practice

WRITING PRACTICES

- Paragraph Writing- Definition-Organizing Principles of paragraphs -Making a paragraph through hints/ graphs and pictures-Coherence-Linking Devices-Systematic Development of Ideas
- Paraphrasing-Précising lengthy expressions for clarity and brevity

LIFE SKILLS: Ethical Values and Humanity The Last Leaf: A Short Story by O. Henry

Self Learning Topics (SLTs):

Articles-(Text 2,Unit-II), English Vocabulary (Text 2,Unit-I, Unit-II, Unit-III)
Verb Forms (Reference book 1,Topic :31), Tenses (Reference book 1,Topics: 16,17,18,19)
Reported Speech (Reference book 2, Exercises for Practice, Topics : 161-167)

UNIT-II	**9 Hrs**

GRAMMAR

- Tenses-Revision-Exercises for practice
- Subject-Verb Agreement
- Reported Speech-Transformation
- Sentence Correction -Emphasis Concord ,Report Speech, Sentence Structures

VOCABULARY

- Synonyms-Antonyms-Single Word Substitutes-Popular Abbreviations

READING STRATEGY

- Emphasis on Scanning the Text-Purpose-Advantages-Examples, Exercises and Practice through Teamwork

WRITING PRACTICES

- Letter Writing- Effective Letter Writing Techniques-Information Seeking Letters-Job Application Letters- Apology Letters-Explanation to Memos- E-mails-Cover Letters-Resume

LIFE SKILLS: Determination

- How I Became a Public Speaker: An essay by George Bernard Shaw

Self Learning Topics (SLTs): *English Vocabulary (Text 2,Unit-I,Unit-II,Unit-III),Tenses (Reference book 3,Topic-30, Exercises,30.1,30.2,30.3)*

UNIT-III	9 Hrs

GRAMMAR

- Tenses-Revision- Exercises for Practice
- Nouns- Prepositions-Adverbs-Adjectives
- Sentence Correction: Correct Use of tenses, nouns, prepositions, adverbs and adjectives

VOCABULARY

- Phrasal Verbs-Technical Words-Latin Words

READING STRATEGY

- Intensive Reading-purpose-Types of Comprehension Questions-Examples, Exercises and Practice through Teamwork

WRITING PRACTICES

- Report Writing-Definition-Purpose-Qualities of a Good Report- Formal and Informal Reports-Report Format-Sample Reports-Exercises
- Emphasis on Technical Reports

LIFE SKILLS: Positive Attitude

- Be the Best of Whatever You Are: A Poem by Douglas Malloch

Self Learning Topics (SLTs):

Parts of Speech (Text book 1,Unit-I),Tenses
(Reference book 1, Topics-16,17,18,19) Phrasal Verbs (Reference book 3)

UNIT-IV	9 Hrs

GRAMMAR

- Tenses-Revision-Exercises for Practice
- Clauses- Conjunctions-Transformation of Sentences
- Sentence Correction (Based on Parts of Speech)- Clauses- Tenses

VOCABULARY

- Appropriate Use of Words in Communication-Commonly Confused Words

ACTIVE READING and NOTE-MAKING

- Note-Making-Definition-Purpose-Effectiveness

WRITING PRACTICES

- Précis Writing- Definition-Purpose-Uses-Examples and Exercises-Practice through Teamwork
- Preparing Statement of Purpose (SoP)

LIFE SKILLS: Emotional Balance A Poison Tree: Poem by William Blake

Self-Learning Topics (SLTs): Tenses (Reference book 2, Topics: 152-157))

Text book(s):

1. Sanjay Kumar & Pushp Lata, " *English Language and Communication Skills for Engineers*", 1st ed., Oxford University Press, 2018
2. "*Language and Life: A Skill's Approach*" 2nd ed., Based on the latest AICTE model curriculum Orient Blackswan Private Limited 2019.

Reference Book(s):

1. Thomson A.J. , Martinet A.V., "*A Practical English Grammar*", 3rd ed., Oxford University Press 1997
2. Thomson A.J. ,.Martinet A.V, "*A Practical English Grammar*", Exercise 2, 3rd ed., Oxford University Press 1997
3. Standard Allen W. , "*Living English Structure*", 5th ed., Pearson India Education Pvt. Ltd., 2009

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc20_hs56/preview *Technical English for Engineers by Aisha Icbal, IIT Madars*
2. https://onlinecourses.swayam2.ac.in/cec21_lg13/preview *Indian Writing in English by Dr.Bindu Ann Philip, St Mary's College Trissur*

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1: apply basic grammar principles in speech and writing, read fast, form new words, make coherent paragraphs and adapt the real value of life.

CO2: create effective letters, e-mails, reply to Memos and do the given tasks with confidence.

CO3: analyze the given texts and write clear and unambiguous reports.

CO4: deduct the superfluous information from lengthy text, prepare SoP (Statement of Purpose) effectively and solve critical problems in life with emotional balance.

Course Articulation Matrix (CAM):		**U24MH205: ENGLISH COMMUNICATION & REPORT WRITING**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24MH105.1**	-	-	-	-	-	1	2	2	2	1	2	1	1
CO2	**U24MH105.2**	-	-	-	-	-	1	2	2	2	1	2	1	1
CO3	**U24MH105.3**	-	-	-	-	-	1	2	2	2	1	2	1	1
CO4	**U24MH105.4**	-	-	-	-	-	1	2	2	2	1	2	1	1
U24MH105		**-**	**-**	**-**	**-**	**-**	**1**	**2**	**2**	**2**	**1**	**2**	**1**	**1**

SPORTS / YOGA

Class: B. Tech. I -Semester		**Branch: common for all branches**	
Course Code:	**U24VA106**	**Credits:**	**1**
Hours / Week(L-T-P-O-E):	**0-0-2-2-4**	**CIE :**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Objectives (LOs): This course Sports/Yoga will enable students to:

LO1: know about Yoga and its Benefits

LO2: develop skills and techniques of various Sports &Games.

LO3: inculcate Sportsman spirit.

LO4: all round development of the students to meet the requirements of the society.

Sports and Games

List of Sports and Games

1. Badminton
2. Basket Ball
3. Chess
4. Carrom
5. Foot Ball
6. Table Tennis
7. Volley Ball
8. Cricket
9. Hand Ball
10. Kabaddi
11. Kho-Kho
12. Yoga Aasanas

Textbook(s):

1. Badminton for Schools – Author -Jake Downey, Publisher - S.Chand & Company Ltd., Ram Nagar, New Delhi-110055. Length: 159 Pages.
2. Basketball Skills & Rules – Author – O.P.Sharma, Publisher – Khel Sahitya Kendra, 4264/3, Ansari Road, Darya Ganj, New Delhi-110002, Length : 166 pages.
3. Title. How to Reassess Your Chess: Chess Mastery through Chess Imbalances. Author: Jeremy Silman, Edition, 4, illustrated, reprint, Publisher: Silman-James Press, 2010, ISBN.1890085138, 9781890085131, Length: 658 pages, Subject: Games & Activities, General.
4. Football Skills & Rules – O.P.Sharma, Publisher – Khel Sahitya Kendra, 4264/3, Ansari Road, Darya Ganj, New Delhi-110002, Length: 215 pages.
5. Teaching & Coaching Table Tennis – Author – Deepak Jain, Publisher – Khel Sahitya Kendra, WP-474, Ist Floor, Shiv Market, Ashok Vihar, Delhi-1100052, Length : 196 pages.
6. Volleyball for Schools, Author – Dave James, Publisher - S.Chand & Company Ltd., Ram Nagar, New Delhi-110055. Length: 125 Pages.
7. Yoga Education, Author – Dr. Tarak Nath Pramanik, Publisher – India's First Publisher & Asia's No.1 Stockist of Physical Education & Sports Books, 7/26, Ground Floor, Ansari Road, Daryaganj, New Delhi-110002, Length : 347 pages.
8. Indian Cricket, 1999 compiled by G.VISWANATH, 53rd Edition, Published by Kasturi &Sons Limited, Chennai-600002, Length : 784 pages.
9. Health And Fitness, Author – Dr.A.K.Srivastava, Sports Publication, 7/26, Ground Floor, Ansari Road, Darya Ganj, New Delhi-110002, Length: 72 pages.
10. Modern Kabaddi, AuthorE .Prasad Rao, Published by D.V.S New Delhi-110019.

Reference Book(s):

1. Rules and Skills of Games and Sports, Author – B.K.Chaturvedi, Publisher – Goodwill Publishing House, B-9, Rattan Jyoti, 18 Rajendra Place, New Delhi – 110008 (India)
2. Dare To Be A Champion. Lee Chong Wei (Brand), Genres **Biography**
3. 199 pages, Paperback, First published July 1, 2012
4. This edition, Format, 199 pages, Paperback, Published, January 1, 2012 by Bukuganda Digital & Publication, ISBN, 9789671084328, ASIN, 967108432X, Language, English.
5. ***The Book of Basketball: the NBA according to the Sports Guy*** is the second book by former ESPN columnist Bill Simmons.[1] Published in 2009, it covers the history of the National Basketball Association (NBA). In 2019, Simmons launched a sequel podcast series, **Book of Basketball 2.0**, which analyzes the evolution of the league since the book was published.
6. Title. How to Reassess Your Chess: Chess Mastery through Chess Imbalances. Author: Jeremy Silman, Edition, 4, illustrated, reprint, Publisher : Silman-James Press, 2010, ISBN.1890085138, 9781890085131, Length : 658 pages, Subject : Games & Activities, General.
7. The Stars of Football: The World's Best Players Kindle Edition by Rodolphe Gaudin (Author) Format: Kindle Edition, Games & Activities / Chess, Games & Activities / General
8. The Complete Volleyball Handbook Kindle Edition, by Bob Bertucci (Author), Makoto Katsumoto (Author), Yasumi Nakanishi (Author), Toshiaki Yoshida (Author) Format: Kindle Edition. 4.5.4.5 out of 5 stars 15 ratings.
9. Cricket skills& Rules, Author.V.Thani, khel sahitya Kendra, 4264/3, Ansari Road, Darya Ganj, New Delhi-110002. Length: 202 pages
10. Health Exercise And Fitness, Author – J.P.Muller, Sports Publication, WP-474, 1st Floor, Shiv Market, Ashok Vihar, Delhi -110052, Length: 117 Pages.
11. Yogic Science, Author – Dr.T.Thangamani, Dr.T.Godwin Vedanayagam Rajkumar, Publisher - Physical Education & Sports Books, 7/26, Ground Floor, Ansari Road, Daryaganj, New Delhi-110002, Length: 274 pages.

Web and Video link(s):

Badminton game Video Link :
https://www.youtube.com/watch?v=HucIqi8Lw3E&t=22s

Basket Ball game Video Link :
https://www.youtube.com/watch?v=-tkE2lJoR58

Chess Video Link :
https://www.youtube.com/watch?v=mDw7lgM8ePo

Carrom game Video Link :
https://www.youtube.com/watch?v=z8vvJpNceeg

Football game Video Link :
https://www.youtube.com/watch?v=mXjW78AgGu4

Table Tennis game Video Link :
https://www.youtube.com/watch?v=bLrJGWvWI4U

Volleyball game Video Link :
https://www.youtube.com/watch?v=BJJb3-O0Q1U

Cricket game Video Link :
https://www.youtube.com/watch?v=87hO_Vs3-wQ
Handball game Video Link :
https://www.youtube.com/watch?v=VCa_0USaq8k
Kabaddi game Video Link :
https://www.youtube.com/watch?v=ai1m7ARNyNI
Kho-Kho game Video Link :
https://www.youtube.com/watch?v=P3_z3LKdLdg
Yoga Aasanas Video Link :
https://www.youtube.com/watch?v=e0Q88DUOXjk
https://www.youtube.com/watch?v=JoDKbXEUrvQ

Course Learning Outcomes(COs):

After completion of this course, the student should be able to …

CO1: demonstrate physical fitness by performing Yoga – Asanas.

CO2: demonstrate physical fitness through various games & sports events with defined benchmarks.

CO3: demonstrate Sportsman spirit and ethics..

CO4: demonstrate Physical, Psychological, Social and Emotional balance.

Course Articulation Matrix (CAM):		**U24VA106 Sports / Yoga for all UG Branches**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24VA106.1**	-	-	-	-	-	-	-	-	-	-	1	-	-
CO2	**U24VA106.2**	-	-	-	-	-	-	-	1	-	-	-	1	-
CO3	**U24VA106.3**	-	-	-	-	-	-	2	-	1	-	-	1	-
CO4	**U24VA106.4**	-	-	-	-	-	-	2	1	1	-	1	-	-
	U24VA106	-	-	-	-	-	-	2	1	1		1	1	-
3 – HIGH, 2 – MEDIUM, 1 - LOW														

ENGINEERING GRAPHICS & CAD

Class: B.Tech. I -Semester		**Branch:** Mechanical Engineering	
Course Code:	**U24ME107A**	**Credits:**	**3**
Hours/Week (L-T-P-O-E):	**1-0-4-4-9**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**72 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: projections of points and straight lines-I
LO2: projections of straight lines-II and planes
LO3: projections of solids and sections of solids
LO4: isometric and orthographic projections using AutoCAD

UNIT-I	**6+12 =18 hours**

Introduction: Importance of Engineering Drawing, principles of engineering drawing, dimensioning, geometrical constructions.

Projection of Points: Introduction to orthographic projections-Vertical Plane, Horizontal plane; Views-Front view, Top view, and Side view; Projection of Points-different quadrants.

Projection of Straight lines - I: Line parallel to both the planes, Line parallel to one plane and perpendicular to the other reference plane, Line parallel to one plane and inclined to the other reference plane.

Self-Learning topics (SLTs) : *Lettering and types of lines*

UNIT-II	**6+12=18 Hrs**

Projection of Straight Lines – II: Line- inclined to both the planes and Traces

Projection of Planes: Planes - Perpendicular and Oblique planes; Projections of planes - parallel to one of the reference planes, inclined to one of the reference planes and perpendicular to the other; Projections of oblique planes.

Self –learning topics (SLTs): *Projection of straight lines inclined to both the planes using trapezoidal method*

UNIT-III	**6+12 =18 Hrs**

Projection of Solids: Types-prisms, pyramids, cylinders, and cone; Simple Positions-axis parallel to a reference plane and perpendicular to the other plane, axis parallel to one plane and inclined to other reference plane; axis inclined to both the reference planes.

Sections of Solids: Types-prisms and pyramids; Section planes, Sectional views, and true shape of a section.

Self-learning Topics(SLTs) : *Projections of solids in auxiliary plane method*

UNIT-IV	**6+12 =18 Hrs**

Orthographic projections: Conversion of isometric views into orthographic views.

Isometric Projections: Isometric axis, Isometric Planes, Isometric View, Isometric projection, Construction of isometric view from orthographic views

Introduction to AutoCAD: Importance of AutoCAD, Standard toolbar, toolbars - draw, modify, dimension and properties, construction of simple diagrams in orthographic and isometric projections.

Self-Learning Topics (SLTs): *AutoCAD commands*

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1*: develop the projections of points and straight lines-I*
CO2*: develop the projections of straight lines-II and planes.*
CO3*: construct projections of solids and analyze internal details of an object through sectional views*
CO4*: construct 2D orthographic views from 3D isometric views and develop 3D isometric views from 2D views (practice in AutoCAD).*

Textbook(s):

1. Bhatt N.D., Panchal V.M. & Ingle P.R., *Engineering Drawing*, Charotar Publishing House, 2014.

Reference Book(s):

1. Shah M.B. & Rana B.C., *Engineering Drawing and Computer Graphics*, Pearson Education, 2008.
2. Agrawal B. & Agrawal C. M., *Engineering Graphics*, TMH Publication, 2012
3. Narayana K.L. & Kannaiah P, *Text Book On Engineering Drawing*, SciTech publishers (Corresponding Set of), 2008.

Web and Video link(s):

1. *https://onlinecourses.nptel.ac.in/noc20_me79/preview NPTEL video link for Engineering* ***drawing and computer graphics*** *By Prof. Rajaram Lakkaraju, IIT Kharagpur.*

Course Articulation Matrix (CAM):		**U24ME107A ENGINEERING GRAPHICS & CAD**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PS O1**	**PSO 2**
CO1	**U24ME107A.1**	2	1	1	-	-	-	1	1	1	1	1	1	1
CO2	**U24ME107A.2**	2	1	1	-	-	-	1	1	1	1	1	1	1
CO3	**U24ME107A.3**	2	1	1	-	-	-	1	1	1	1	1	1	1
CO4	**U24ME107A.4**	2	1	1	-	2	-	1	1	1	1	1	1	1
U24ME107A		**2**	**1**	**1**	**-**	**2**	**-**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

PRACTICUM-1			
Class: B.Tech. I -Semester	**Branch:** Common to all branches		
Course Code:	**U24EL108**	**Credits:**	**1**
Hours/Week (L-T-P-O-E):	**0-0-0-4-4**	**CIE:**	**100%**
Total Number of Teaching Hours:	**-**	**ESE :**	**-**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: literature review and identifying research gaps

LO2: implementing a project independently by applying knowledge to practice

LO3: preparing well-documented report and informative PPT

LO4: effective technical presentation and creating video pitch

Practicum is an independent project carried out by the student during the course period, under the supervision of allotted course faculty. It helps to reinforce the students' theoretical knowledge and develop their ability to apply this knowledge to the solution of practical problems. Practicums also prepare them for their MINI and MAJOR PROJECTs and for independent work in their chosen field that promotes creative abilities. Besides they provide Higher Order Cognitive Abilities (HOCAs).

(i). Practicum is a mandatory semester project work.

(ii). Practicum is offered as a one credit course. Student has to earn 4 credits (one in each semester from I to IV semesters)

(iii). Allotment of Practicum topics for students:

- **Practicum matrix:** In week (-1), the class teacher, in consultation with HoD, shall prepare the practicum matrix of the section. The practicum matrix is the allotment of group of students to the different course faculty of the section, as shown below.

Course	U24MH101	U24PS102	U24EC103	U24CS104	U24EE105	U24CH106
Students allotted to different courses	B24XX001	B24XX011	B24XX021	B24XX031	B24XX041	B24XX051
	B24XX002	B24XX012	B24XX022	B24XX032	B24XX042	B24XX052
	B24XX003	B24XX013	B24XX023	B24XX033	B24XX043	B24XX053
	B24XX004	B24XX014	B24XX024	B24XX034	B24XX044	B24XX054
	B24XX005	B24XX015	B24XX025	B24XX035	B24XX045	B24XX055
	B24XX006	B24XX016	B24XX026	B24XX036	B24XX046	B24XX056
	B24XX007	B24XX017	B24XX027	B24XX037	B24XX047	B24XX057
	B24XX008	B24XX018	B24XX028	B24XX038	B24XX048	B24XX058
	B24XX009	B24XX019	B24XX029	B24XX039	B24XX049	B24XX059
	B24XX010	B24XX020	B24XX030	B24XX040	B24XX050	B24XX060

- In week (-1), the class teacher of a section shall collect 10-12 topics for practicum from each of the course teachers of that section.
- The class teacher, in consultation with HoD shall allot the practicum topics to the students of that section in the following format.

****

CIRCULAR

Allotment of Practicum topics to students

Section : …….

S. No.	Roll number of the student	Practicum topic allotted	Practicum under the course	Course faculty

Note:

1. The students should meet immediately the allotted course faculty for practicum and start working on the practicum with the guidance of course faculty.
2. To complete the Practicum, the student shall work in laboratories under supervision of allotted course faculty, in the allotted hours in the classwork timetable and also outside the class work hours during weekdays.
3. The course faculty are advised to guide the allotted students for practicum during the semester course work.

(Signature of class teacher)

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(iv). ***To complete the practicum, the student shall work in laboratories under supervision of allotted course faculty, in the allotted hours in the classwork timetable and outside the class work hours during weekdays.***

(v). There shall be only continuous Internal Evaluation (CIE) for practicum for a maximum of 100 marks.

(vi). The practicum course faculty shall evaluate & submit the final marks of the allotted students in week (N+1) to the respective class teacher.

(vii). The class teacher shall collect the final marks of practicum of the students allotted to each course teacher and submit them to the CoE.

(viii). Course faculty shall follow his/her own rubrics for practicum evaluation. Focus shall be on knowledge, skills & qualities acquired by the student during the practicum course

(ix). A sample rubrics for assessment and evaluation of practicum is as follows:

Literature survey & Identification of research gaps	10 marks
Working model / process / software package / system developed	30 marks
Report writing (subjected to max of 30% plagiarism)	20 marks
Oral presentation with PPT and viva-voce	20 marks
Video pitch	20 marks
Total	100 marks

Note: It is mandatory for the student to appear for oral presentation and viva-voce to qualify for course evaluation of Practicum.

(a) **Practicum Topic**: Each student shall be allotted a topic for practicum by the course faculty member attached to him/her. Interested students can work on their own title for practicum, but with due approval from course faculty.

(b) **Working Model**: Each student is required to develop a prototype / process / system/simulation model on the given practicum topic and demonstrate/present, during the allotted time, before the course teacher.

(c) **Report:** Each student is required to submit a well-documented report on the allotted practicum topic as per the format specified by the course faculty. The student shall include answers to the following questions in the report and ppt presentation.

- What was the objective of the practicum assigned?
- What are the main responsibilities and tasks for practicum?
- What knowledge and skills from the coursework are applied in the practicum?
- What new knowledge and skills are acquired during the practicum?
- In what ways, can the practicum be helpful for the professional career?
- What gaps are identified in your practicum work?

- What improvements or changes you suggest for addressing the identified gaps for future work?

(d) **Anti-Plagiarism Check:** The practicum report should clear plagiarism check as per the Anti-Plagiarism policy of the institute

(e) **Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the course teacher as per the schedule notified by the department

(f) **Video Pitch:** Each student should create a pitch video, which is a video presentation on his / her Practicum. Video pitch should be no longer than 5 minutes by keeping the pitch concise and to the point, which shall also include evidence like videos & pics at the time of implementing the practicum and also key points about his / her business idea / plan (*if any*) and social impact

(g) The student has to register for the Practicum as a supplementary examination in the following cases:

i) he/she is absent for oral presentation and viva-voce

ii) he/she fails to submit the report in prescribed format

iii) he/she fails to fulfill the requirements of Practicum evaluation as per specified guidelines

Course Learning Outcomes (COs):

After completion of this course, the students should be able to…

CO1: synthesize literature survey, identify research gaps and define objective & scope of practicum problem

CO2: apply knowledge to design & conduct experiments, utilize modern tools for solution of practicum problem and develop working model/ process/ system

CO3: demonstrate the generic competencies in making a well-documented report portraying knowledge, skills, qualities acquired through practicum

CO4: create a video pitch on practicum and make an effective oral presentation using PPTs

Course Articulation Matrix (CAM):		**U24EL108 PRACTICUM-1**											
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24EL108.1**	2	2	2	2	2	2	2	2	2	2	2	2	2
CO2	**U24EL108.2**	2	2	2	2	2	2	2	2	2	2	2	2	2
CO3	**U24EL108.3**	2	2	2	2	2	2	2	2	2	2	2	2	2
CO4	**U24EL108.4**	2	2	2	2	2	2	2	2	2	2	2	2	2
	U24EL108	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**	**2**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

Course code U24ELXYY: ***X represents semester, YY represents ETA course serial number***

SOCIAL EMPOWERMENT ACTIVITY / SELF ACCOMPLISHMENT ACTIVITY (SEA /SAA)			
Class: B.Tech. I -Semesters	**Branch:** Common to all branches		
Course Code:	**U24VA109 (SE/SA)ZZZ**	**Credits:**	**1**
Hours/Week (L-T-P-O-E):	**0-0-0-2-2**	**CIE:**	**100%**
Total Number of Teaching Hours:	**-**	**ESE :**	**-**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: holistic development through activity-based learning to gain real-life experience which effectively help individuals deal appropriately with problems/challenges

LO2: positive mindset by actively adopting optimism, acceptance, resilience, gratitude, mindfulness, and integrity and handling rejection in life

LO3: skills for effective fieldwork practice, which include ethics, observation, communication, interviewing, problem solving, time management, organisation and documentation

LO4: making a well-documented report and an effective oral presentation through PPTs portraying knowledge, skills, qualities acquired and social impact of the activity

Activity Based Liberal Learning about Life, Literature and Culture (ABLL@LLC) is introduced for building **generic competencies** in students. ABLL is aimed at all dimensional holistic growth of the learner. The holistic development includes the **physical, emotional, cognitive, spiritual and social aspects**. This is an area which opens the decision-making process, helps the student to develop creativity, an analytical mind, and builds resilience, confidence, hope, well-being and success. This will help student face the world with a greater degree of maturity, stoic and become a wholesome person in the society.

It is more than just learning from books to lead a successful life. These activity-based liberal learning courses, which help students to expand their social roles later in life, are offered under two sequels namely **SEA** (Social Empowerment Activities) and **SAA** (Self Accomplishment Activities)

These SEA/SAA courses also focus on building positive mindset: adopting optimism, acceptance, resilience, gratitude, mindfulness, and integrity in your life will help student develop and maintain a positive mindset.

(a) Each SEA/SAA activity is treated as one credit course
(b) Student must select one activity per semester, through first 04 semesters, from the courses listed under SEA/ SAA, before commencement of the semester.
(c) Students are required to earn minimum 04 credits under SEA/SAA, by completing minimum 02 credits through SEA and minimum 02 credits through SAA
(d) To complete these activities student shall work outside the class work hours, during weekends, holidays, semester breaks, etc.,
(e) If a student is not able to attend/ fulfil performance requirements, he/she shall be dropped from the course and shall have to enrol in the forthcoming semesters.

Monitoring SEA/SAA:

(a) **Nodal units:** The Student Activity Centre (SAC) and Centre for Innovation Incubation Research and Entrepreneurship (C-i²RE) shall act as nodal units for activities listed under SEA/SAA.
(b) During the semester period, the student has to **acquire requisite knowledge**, **conduct fieldwork**, acquire skills and propose unique solutions to the real-life problems
(c) **Knowledge Acquisition & Skilling**:
   i. Students have to identify goals, acquire and accumulate knowledge on the chosen SEA/SAA activity
   ii. For the activities related to social awareness/issues/challenges that affect society, use the knowledge base, apply relevant skills to analyse the issue and propose unique possible solutions to the social issues/challenges. Practice to acquire necessary skills to seek new opportunities in their personal and professional life.
   iii. For the activities related to physical fitness, music, dance, fine arts, etc., guided practice sessions under supervision of expert/guru are to be planned and executed to acquire the benchmark skills to be demonstrated.

(d) **Fieldwork:** Fieldwork is an essential component of learning for gaining real-life experiences. In addition to knowledge acquisition & skilling, student has to take up fieldwork on the chosen activity, as part of SEA/SAA course.

i. This student-driven Fieldwork allow students to interact with the 'real world'. It is an autonomous learning (self-learning) situation that students are more actively involved during the activity and develop a deeper understanding and develop a more positive attitude.

ii. Fieldwork consists of three phases: preparation, the actual activity and feedback

iii. **As part of fieldwork, student has to interact with at least two eminent personalities/achievers/renowned persons/inspiring and great personalities related to the activity chosen.**

iv. Fieldwork will benefit students for any careers where they need to work with communities of people or which involves analysis of complex processes, especially social and cultural.

v. Certain skills are required for effective fieldwork, which include observation, communication, interviewing, problem solving, documentation, and more

vi. Other skills important for fieldwork practice include the ability to act in a crisis, to plan, set priorities, mobilize resources, and implement the plan effectively. These skills used in an integrated manner help students solve their problems and to develop one's own leadership style based on the need and culture of the place.

vii. **Eminent personalities/achievers/renowned persons/inspiring and great personalities**

Eminent personalities/ Achievers / Renowned personalities:

(a). **In case of socially relevant problems/ activities of SEA/SAA: E**minent personalities/ achievers include district administrative officers, Eminent Social workers / NGOs, other inspiring and great personalities

(b). **In case of Sports / Games and Cultural activities of SEA/SAA:** Eminent coaches/ trainers/gurus, achievers who represented/won state level/national level /international level competitions, other inspiring and great personalities.

viii. **For appointment to interact eminent personalities**: Student is expected to follow email etiquette rules and other appropriate polite communication etiquettes for getting appointment and time for interaction

ix. On fieldwork, student is expected to demonstrate solid time management, organisational and note taking skills during fieldwork

x. **Ethics of fieldwork**: Fieldwork is an educational process with commitment to positive values. All fieldwork should be planned and conducted in a way that is ethical, responsible and safe, for people, students, visited communities, if any, and all other stakeholders. Student is expected to maintain integrity and honesty. Avoid bias and deception. Protect the rights and well-being of people involved in fieldwork. The privacy, confidentiality and respect for the eminent people interacted should be maintained and their time, inputs & guidance are to be acknowledged

xi. Student is expected to take care of health and Safety practices for fieldwork and travel

xii. Student should remember that contrary to a *field trip or company visit*, **the emphasis in fieldwork is on acquiring skills**, and not on casually presenting theory and assessing.

xiii. For the fieldwork, student shall go with a scientifically designed questionnaire and record the responses during interaction. These response sheets, along with geo-tagged pic of fieldwork (at the time of interaction & practise sessions, if any) shall be appended as annexures in the report to be submitted for course evaluation.

xiv. **Feedback:** The learnings the student made out of interaction with eminent achievers shall be presented in the report as one of the chapters.

- During feedback, the central focus is on the elaboration of the students' experience during fieldwork. Therefore, the student should create an end product, such as a demonstration/presentation and report in which they demonstrate a link between their experiences during fieldwork and the underlying theoretical concepts and ideas.

(e) **Demonstration / Presentation and Report**: Student after presentation/demonstration of his/her achievements/work, shall get a certificate from the concerned nodal unit and submit a report, in the prescribed format, to the faculty counsellor for award of grade.

(f) **Flow process for completion of SEA/SAA course**:

i. ***Faculty counsellor approval***: In week (-1), in consultation with faculty counsellor, every student shall, identifies minimum of 4 activities listed under SEA/SAA activities, lists their priority and fills the same in ONLINE REGISTRATION FORM FOR SEA/SAA (received in their domain mail id) to Dean, Student Affairs. Dean, Student Affairs shall release the section wise allotment of SEA/SAA courses to students along with the details of supervising faculty of nodal centre. The allotment details shall be shared to the SEA/SAA coordinator and the student through domain mail id of the student

ii. ***Identification of goals and preparation of action plan:*** In week (1), the respective faculty coordinator(s) of nodal centres shall address the students allotted to them to educate them on fixing goals, plan of action for completion and evaluation. In consultation with nodal centre, based on the workflow of the allotted activity, every student shall identify the goals (of activity) & eminent personalities (to be visited during the field trip) and prepare action plan (oriented workflow) for attaining the identified goals.

iii. ***Field work:*** Under the guidance of nodal centre, student shall complete the field work, based on the action plan, with the progress continuously monitored by the faculty counsellor and the nodal centre.

iv. ***Demonstration/ Presentation:*** After completion of field work, student shall demonstrate/present his achievements (knowledge/skills gained during the activity) at the nodal centre in the presence of external experts/senior practitioners of the activity. After successful demonstration/presentation, the nodal centre shall provide a certificate of completion indicating that the student has completed the activity in the stipulated time.

v. ***Report writing:*** After successful demonstration/presentation, student shall write a 2–3-page report and submit the same to the faculty counsellor. The report shall emphasize knowledge, skills and qualities acquired through the SEA/SAA activities. It shall also include the influence of these activities on enhancing confidence, positive change in life, decision making, transforming choices into desired actions/outcomes.

(g) ***Assessment & Evaluation:*** There shall be *only Continuous Internal Evaluation (CIE) for SEA/SAA*. The SEA/SAA activities shall be evaluated at the end of the semester through respective evaluation processes, which shall include field work, presentation/ demonstration, submission of reports on the gathered data/information/ surveys, the details of which have been shown in below table. The department level SEA/SAA coordinator shall collect marks from the nodal centres and faculty counsellors, consolidate them, and submit the final grades to the examination branch, within one week of the last day of instruction. Evaluation of SEA/SAA activities shall be completed as and when students are ready, but not later than week (N+1).

The CIE for SEA/SAA is as follows:

Assessment	Maximum marks	Marks to be awarded by
Goal setting, Planning & Knowledge Acquisition	20	Nodal centre
Field work	40	Nodal centre
Demonstration/Presentation	20	Nodal centre
Report submission	20	Faculty counsellor
Total	**100**	**-**

Note:

(a) **<u>Presentation/ Demonstration:</u>** It is mandatory for the student to appear for demonstration and (or) oral presentation oral presentation to qualify for course evaluation. In case of presentation, student should prepare PPT with informative slides including the geo tagged photos of his/her field trips/interactions as per the schedule notified by the nodal centre. In case of demonstration, student must take timeslot from the nodal centre and demonstrate the skills learnt/improved during the allotted timeslot.

- The necessary arrangements for demonstration shall be looked after the student in consultation with the coordinator with due permission from Head of the department.

(b) **Report:** Each student is required to submit a well-documented report on the chosen SEA/SAA topic as per the format specified by *department level SEA/SAA coordinator*.

(c) **Anti-Plagiarism Check:** The SEA/SAA report should clear plagiarism check as per the Anti-Plagiarism policy of the institute.

(d) **Requirements for passing the course:** A student is deemed to have passed SEA/SAA if he/she
   a. successfully demonstrates/presents the skills attained at the end of course as per the schedule notified by the nodal centre, **and**
   b. scores a minimum of 40 marks in the CIE of the course

(e) **Supplementary examination:** If a student fails in SEA/SAA activity of a particular semester, he must complete the same by enrolling it in the next higher semesters.

Course Learning Outcomes (COs):

After completion of this course, the students should be able to…

CO1: integrate the five dimensions of physical, emotional, cognitive, spiritual and social aspects in life for holistic development and demonstrate social sensibility

CO2: interact effectively through written, oral and nonverbal communication with external-world in a professional, sensitive and culturally relevant manner

CO3: analyse the issues related to social empowerment / self-accomplishment, demonstrate problem-solving skills, articulate solutions and demonstrate social sensibility

CO4: demonstrate the generic competencies in making a well-documented report and an effective oral presentation with PPTs portraying knowledge, skills, qualities acquired through fieldwork/practice sessions and social impact of the course learning

Text / Reference book(s):

For knowledge acquisition, students shall refer to textbooks and web resources relevant to the course selected. Plan for fieldwork/practice sessions in coordination with SEA/SAA coordinator

Course Articulation Matrix (CAM):		**U24VA109 (SE/SA)ZZZ- Courses listed under SEA/ SAA**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24VA109.1**	-	-	-	-	-	2	2	2	2	2	2	-	-
CO2	**U24VA109.2**	-	-	-	-	-	2	2	2	2	2	2	-	-
CO3	**U24VA109.3**	-	-	-	-	-	2	2	2	2	2	2	-	-
CO4	**U24VA109.4**	-	-	-	-	-	2	2	2	2	2	2	-	-
	U24VA109	-	-	-	-	-	2	2	2	2	2	2	**-**	**-**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

Course Code: **U24VA109 (SE/SA) ZZZ**

***X** represents semester; YY represents SEA/SAA course serial number in that semester; SE- represents SEA activity or SA – represents SAA activity; ZZZ represents activity code from SEA/SAA baskets*

Ex: If A student selects a SEA/SAA course as below:	Ex: If A student selects a SEA/SAA course as below:
Semester: 1 *SEA/SAA course serial number: 09* *SEA/SAA category: SEA* *course number: 302* The **course code** will be U24VA109SE302	*Semester: 4* *SEA/SAA course serial number: 10* *SEA/SAA category: SAA* *course number: 206* The **course code** will be U24VA410SA206

EXPERT TALK SERIES-1			
Class: B.Tech. I -Semester	**Branch:** Common to all branches		
Course Code:	**U24AE110**	**Credits:**	**1**
Hours/Week (L-T-P-O-E):	**0-0-0-1-1**	**CIE:**	**100%**
Total Number of Teaching Hours:	**-**	**ESE :**	**-**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: 21st century skills needed for industry, current industry trends, challenges and innovations

LO2: latest technology in practice and applying knowledge to solve real-world problems

LO3: smart work, soft skills, professional etiquette, networking abilities

LO4: making a well-documented report portraying the knowledge, skills, qualities acquired and the impact of the learning

In the 21st century, for successful career, degree alone won't suffice. Competencies are much more important.

(a) You need to be aware of the real-world problems, industry working style, need to be confident and smart and you also need to know the tricks of the trade.

(b) Learning from industry experts with real-world examples, is important to enhance your educational experience.

(c) Enhanced graduate employability benefits all stakeholders. To effectively enhance employability and the immediacy of adding value to company/project, it is important that you are aware of what you are learning and its use in the workplace. The cognitive abilities viz., remember, understand, recall, and application of knowledge and other skills acquired in higher education can be maximised if you are clear on the purpose of your developed competencies and how to apply them in a range of complex situations.

(d) Graduate employability could be enhanced through fostering lifelong learning, the development of a range of employability-related competencies and increased confidence and capacity in "reflecting on and articulating these capabilities and attributes in a range of recruitment situations".

But how would you know all this without venturing into the industry?

(e) The answer is Industry **Expert Talk Series (ETS)**. Through ETS, we invite industry experts in different fields to deliver talks and interact with students.

(f) Through Industry expert talks students get to know so much more that textbooks don't explain.

(g) Students have the opportunity to learn from professionals who have achieved success in their respective fields. These speakers often share their personal experiences, case studies, and anecdotes, providing students with real-world examples and perspectives that go beyond theoretical concepts.

(h) Our competency-focussed curriculum URR24 is designed to contribute greatly to the nurturing and development of each of these facets among students through ETS courses

(i) ETS helps students gain improved industry engagement for an easier transition into the workplace, broader career progression opportunities and personal development.

(j) In URR24 curriculum, Expert talk series (ETS) is offered as a course under **ability enhancement category of courses**.

(k) Through ETS sessions, students get the chance to interact with industry regularly which helps them focus on the needs and requirements of current industry. This will not only enthuse the students with new ideas but also motivate them to understand

what kind of 21st century skills are needed in industry and how they need to groom themselves.

(l) Through ETS sessions, another benefit is that students learn the importance of soft skills like communication, presentation, email etiquettes, corporate grooming and dressing styles. Conversing with successful people is the biggest motivation and students gain in more ways than one through ETS sessions.

(m) ETS enhances your learning in many ways for global opportunities for your career.

(n) All in all, learning from industry experts**,** is a wonderful opportunity for student to getting acquainted with professional etiquette, acquiring professional knowledge, and getting to know the internal workings of an organization.

(o) Salient features of ETS are hereunder:

(i) ETS is offered from I semester to VI semester.

(ii) ETS, in any given semester, is treated as one credit course

(iii) Students are required to earn six credits (from I to VI semester)

(iv) **Head, Centre for i²RE** shall be the **institute level ETS coordinator**

(v) Under this course, a minimum of 10 expert talks shall be organized in **online/offline mode** by the parent department / Centre for i²RE.

(vi) Each expert talk shall be for a minimum duration of 45 minutes (*but not exceeding 90 minutes*) followed by **online quiz/test** for 10 marks (10 MCQs/FiBs ; *duration: 10-15 mins*), on the contents covered in the expert talk.

(vii) **The Head C-i²RE** shall share the marks obtained by the students in each of the quizzes / tests to the respective **department ETS coordinators.**

(viii) Each student shall attend a minimum of 6 expert talks and attempt the corresponding quizzes/ tests conducted at the end of the talks.

(ix) **Report on ETS:** At the end of semester, the student shall submit a well-documented report on the acquired knowledge and skills, in the prescribed format, to the department ETS coordinator.

(x) **Evaluation:** There shall be only continuous Internal Evaluation (CIE) for ETS for a maximum of 100 marks

(xi) The department ETS coordinator shall, in coordination with institute level ETS coordinator, submit the final scores to the CoE in week (N+1).

(p) The CIE for ETS is as follows:

Rubrics for evaluation of ETS

Quiz score (*sum of best 6 quiz scores out of 10 quizzes. Each quiz evaluated for 10 marks*)	60 marks
Attendance (*out of 10 quizzes*)	20 marks
Report in prescribed format (*max 30% plagiarism*)	20 marks
Total	100 marks

i. **Attendance**: Maximum of 20 marks shall be awarded based on the attendance maintained by the student over a maximum of 10 lectures.

$$Marks\ for\ attendance = \frac{Number\ of\ expert\ talks\ attended\ fully}{10} * 20$$

ii. Supplementary Exam:

(a) Student has to register for ETS supplementary examination if he/she scores less than 40 marks in CIE

(b) The ETS supplementary examination shall be conducted by the parent department, in physical mode, for 100 marks (MCQs/FiBs ; *duration: 2Hrs*) on the content covered in ETS lectures.

(c) Department ETS coordinator shall, in coordination with the institute level ETS coordinator, conduct the supplementary exam, and submit scores to the CoE

(d) Exam material/resources for supplementary: Recorded videos of ETS arranged for that semester, which shall be made available on ETS webpage of institute website

Course Learning Outcomes (COs):

After completion of this course, the students should be able to…

CO1: identify real-world problems, different career paths, industry requirements, emerging job roles, business practices and exploit new opportunities by staying up-to-date with industry knowledge, trends and technology

CO2: identify what 21st century employability-related skills and professional etiquette are must in a range of recruitment situations, what skills are absent in him/her, and demonstrate skill improvement

CO3: interact with experts, exhibit confidence, demonstrate improved communication and networking abilities potentially leading to mentorship opportunities, internships, or even future job prospects

CO4: demonstrate the generic competencies in making a well-documented report portraying knowledge, skills, qualities acquired through ETS sessions and impact of the expert talks

Course Articulation Matrix (CAM):		**U24AE110 EXPERT TALK SERIES-1**											
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	U24AEX110.1	1	1	1	1	1	1	2	1	2	1	2	1	1
CO2	U24AEX110.2	1	1	1	1	1	1	2	1	2	1	2	1	1
CO3	U24AEX110.3	1	1	1	1	1	1	2	1	2	1	2	1	1
CO4	U24AEX110.4	1	1	1	1	1	1	2	1	2	1	2	1	1
U24AE110		**1**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**2**	**1**	**2**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

Course code U24AEXYY: ***X represents semester, YY represents ETA course serial number***

Stream-II

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	BSC	U24MH201	Matrix Theory and Vector Calculus	2	1	-	3	3
2	BSC	U24PY202A	Engineering Physics	2	1		3	3
3	PCC	U24ME203	Engineering Materials and Metallurgy	2	1	-	3	3
4	ESC	U24ME204	Data Structures through C	2	1		3	3
5	ESC	U24EE205A	Basic Electrical & Electronics Engineering from Pool - II	2	1		3	3
6	VAC	U24CY206	Environmental Studies	2	-	-	2	1
7	AEC	U24AE207	IDEA Lab Makerspace	-	-	2	2	1
8	BSC	U24PY209A	Engineering Physics Laboratory	-	-	2	2	1
9	ESC	U24ME210	Data Structures through C Laboratory	-	-	2	2	1
10	ESC	U24EE211A	Basic Electrical & Electronics Engineering Laboratory	-	-	2	2	1
Total:				**12**	**5**	**10**	**25**	**20**
Summer / Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)								

Pool – I (Physics)		
Sr. No.	**Course Code**	**Course Title**
1.	U24PY202A	Engineering Physics *(for Mechanical Engineering)*
2.	U24PY202B	Engineering Physics *(Common to CSM, CSD, CSN, CSO & IT)*

Pool – II (Basic Electrical & Electronics Engineering)		
S. No.	**Course Code**	**Course Title**
1.	U24EE205A	Basic Electrical and Electronics Engineering *(for Mechanical Engineering)*
2.	U24EE205B	Basic Electrical Engineering *(Common to CSM, CSD, CSN, CSO & IT)*

Bridge Courses for exit:

Successful completion of two subjects (6-Credits) during 2-months internship at the institute
OR
Successful completion of two suitable skill based courses (external) to qualify for Certification

A. After First Year: (UG Certificate in ME)

(i) The candidate should pass any two of the following additional courses (ITI Level) during the 2-Months internship at institute

Exit Option to Qualify UG Certificate in ME: Any Two (02) Courses during the 2 - Months internship								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	PCC	U24ME212X	Internal Combustion Engines	**2**	**-**	**2**	**4**	**3**
2	PCC	U24ME213X	Machine Drawing & Modelling	**2**	**-**	**2**	**4**	**3**
3	PCC	U24ME214X	Basic Mechanical Engineering	**2**	**-**	**2**	**4**	**3**
4	PCC	U24ME215X	Any other course approved by BoS Chair and Dean AA	**2**	**-**	**2**	**4**	**3**

(OR)

(ii) Any two suitable skill based courses to qualify for Certification.

Exit Option to Qualify UG Certificate in ME: Any Two (02) Skill based Courses -:								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	SEC	U24SE212X	Certificate course in Product Design and Development (Offered by MSME CITD)	**-**	**-**	**6**	**6**	**3**
2	SEC	U24SE213X	Foundry men (NSQF)	**-**	**-**	**6**	**6**	**3**
3	SEC	U24SE214X	Mechanic Diesel (NSQF)	**-**	**-**	**6**	**6**	**3**
4	SEC	U24SE215X	Certificate Course in Product Design and Manufacturing (CITD)	**-**	**-**	**6**	**6**	**3**
5	SEC	U24SE216X	Any other skill based course approved by BoS Chair and Dean AA	**-**	**-**	**6**	**6**	**3**

MATRIX THEORY AND VECTOR CALCULUS

Class: B. Tech. II -Semester		**Branch:** Common to all branches	
Course Code:	**U24MH201**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: various methods of solving system of linear equations and eigen value problems

LO2: double integral, triple integral and their applications

LO3: vector differential calculus and applications

LO4: integration of vector valued functions and applications

UNIT-I	**9 Hrs**

Matrices:

Rank of a Matrix, Elementary transformations of a matrix, Gauss Jordan method of finding the inverse, Normal form of a matrix, Consistency of linear system of equations, System of linear homogenous equations, Eigen values, Eigen vectors, Properties of Eigen values, Cayley Hamilton's theorem, Reduction to diagonal form, Factorization method (LU Decomposition)

Applications of Eigen value problems: Stretching of an elastic membrane, Eigen value problems arising from Markov processes, Eigen value problems arising from population models, Leslie model

Self-Learning Topics (SLTs): *Review of Matrices [Text 1: topics 2.1,2.2,2.3,2.4,2.5]*

PAQ –Normal form [Text 1, topic 2.7(7), Solved problems: 2.26, Practice problems: exercise 2.4 (9,10)]

Additional problems on System of homogeneous and non-homogeneous equations [Text 1: topic 2.18, Solved problems: 2.52, Practice problems: exercise 2.10 (13,14)]

Additional problems on Eigen values and Eigen vectors [Text 2: topic 8.1, Solved problems: 8.1(1,2), Practice problems: exercise 8.1(4,6)]

Nature of Quadratic form [Text 1: topic 2.18, Solved problems: 2.52, Practice problems: exercise 2.10 (13,14))

UNIT-II	**9 Hrs**

Multiple Integrals and Beta, Gamma functions:

Double Integrals, change of order of integration, Double Integrals in polar coordinates, Area enclosed by plane curves, Triple integrals, Volumes of solids, Calculation of Mass for a plane lamina, Beta function, Gamma function, Relation between Beta and Gamma functions (without proof)

Self-Learning Topics (SLTs): *Review of integrals [Text 1: topic Appendix VII (1)*

Additional problems on change of order of integration [Text 1: topic 7.2, Solved problems: 7.4,7.6, Practice problems: exercise 7.1 (9,14))

Centre of gravity of a plane lamina [Text 1: topic 7.10, Solved problems 7.34,7.35, Practice problems: exercise 7.6 (9,10)]

Moment of Inertia of plane lamina [Text 1: topic 7.12(1,2), Solved problems: 7.37,7.38, Practice problems: exercise 7.7 (1,4)]

Additional problems on Volume of solids [Text 1: topic 7.6, Solved problem: 7.21, Practice problems: exercise 7.4 (12,25)]

UNIT-III	**9 Hrs**

Vector Calculus and its applications: - Vector Space, Linear dependent and independent vectors, Differentiation of vectors, Curves in space, Tangent, Principal normal, Binormal, Curvature, Torsion, Velocity and acceleration, Scalar and vector point functions, Del applied to scalar point functions - Gradient, Geometrical interpretation, Directional derivative, Del applied to vector point functions -Divergence, Curl, Physical interpretation of divergence, Physical interpretation of curl, Del applied twice to point functions, Del applied to products of point functions, Decomposition of vector valued functions

Self-Learning Topics (SLTs): *Review of vectors [Text 2: topics 9.1, 9.2, 9.3]*

Vector identities [Text 1: topic 8.9, Solved problems: 8.22, 8.23, Practice problems: exercise 8.4 (13,14)]

Additional problems on Directional derivatives [Text 1: topic 8.5(3), Solved problems: 8.13,8.14, Practice problems: exercise 8.3 (4,6,8,9)]

UNIT-IV	9 Hrs

Integration of vectors:

Line integral, Surfaces-Surface integral, flux across a surface, Green's theorem in the plane (without proof), Stoke's theorem (Relation between line and surface integrals) (without proof), Volume integral, Gauss divergence theorem (Relation between surface and volume integrals) (without proof), irrotational fields, solenoidal fields

Self-Learning Topics (SLTs): *Additional problems on Green's theorem [Text 1: topic 8.13, Solved problems: 8.33,8.35, Practice problems: exercise 8.8 (1,2,4)]*

Additional problems on Stoke's theorem [Text 1: topics 8.14, Solved problems: 8.39, 8.40, Practice problems: exercise 8.9 (1,2)]

Additional problems on Gauss Divergence theorem [Text 1: topic 8.16, Solved problems: 8.44,8.46, Practice problems: exercise 8.10 (1,2)]

Course Learning Outcomes (COs):

After completion of this course, the students should be able to…

CO1: analyze eigen value problems using matrix theory

CO2: apply basic concepts of multiple integrals in evaluating physical quantities of real-life engineering problems

CO3: apply differential operators on vector and scalar point functions

CO4: solve line, surface, volume integrals and correlate these with applications of Green, Stoke and Gauss divergence theorems

Textbook(s):

1. Grewal, B.S., *Higher Engineering Mathematics*, 44th ed., Delhi: Khanna Publishers, 2017 (Chapters 2,7,8)
2. Kreyszig E, *Advanced Engineering Mathematics*, Inc, 10th ed., U.K: John Wiely & Sons, 2020 (Chapter 8(8.2))

Reference Book(s):

1. Spiegel M, *Vector Analysis -Schaum's Series,* 2nd ed., McGraw Hill, 2017
2. S.S. Sastry, *Engineering Mathematics,* Vol.II, 3rd ed., Prentice Hall of India, 2014.
3. Gilbert Strang, *Introduction to Linear Algebra*, 5th ed., Wellesley-Cambridge Press

Web and Video link(s):

1. https://youtu.be/L4crGhtEX14?si=hyjAPgDheJOhXtYZ : *NPTEL Video Lecture on Matrix Analysis with Applications/Dr.S.K.Gupta and Dr.Sanjeev Kumar/IIT Roorkee*
2. https://youtu.be/ksS_yOK1vtk?si=CNNA58OIuszubPiX : *NPTEL Video Lecture on Integral and Vector Calculus./Prof.Hari Shankar Mahato / IIT Kharagpur*

Course Articulation Matrix (CAM):		**U24MH201 MATRIX THEORY AND VECTOR CALCULUS**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24MH201.1**	2	2	1	1	-	-	-	1	1	-	1	1	1
CO2	**U24MH201.2**	2	2	1	1	-	-	-	1	1	-	1	1	1
CO3	**U24MH201.3**	2	2	1	1	-	-	-	1	1	-	1	1	1
CO4	**U24MH201.4**	2	2	1	1	-	-	-	1	1	-	1	1	1
U24MH201		**2**	**2**	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**-**	**1**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

ENGINEERING PHYSICS (*for Mechanical Engineering)*			
Class: B. Tech. II -Semester		**Branch:** ME	
Course Code:	**U24PY202A**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: crystal structure, imperfections in solids and instrument characteristics

LO2: force systems, concepts and applications of friction

LO3: centroid, moment of inertia of different objects and operation of lasers

LO4: V-I characteristics, materials performance and applications of solar PV systems

UNIT-I	**9 Hrs**

Crystallography: Space lattices, Unit cells, Crystal structure, Crystal systems, Atomic packing factors, Crystal planes and directions, Miller indices, Bravais lattices, Crystal imperfections- Point defects, Line defects and Surface defects, Crystal deformation- Slip and Twinning

Characteristics of Instruments: Static characteristics- Range and span, Accuracy, Error and correction, Calibration, Hysteresis and dead zone, Drift, Sensitivity, Threshold and resolution, Precision, Repeatability and reproducibility, Linearity; Dynamic characteristics- Speed of response and Measuring lag, Fidelity and dynamic error, Overshoot, Dead time and dead zone; Linear measurement- Vernier caliper and Micrometer

***Self Learning Topics (SLTs)**: Slip and Twinning (Text1: topics 2.1, 2.2), threshold and resolution, precision, repeatability and reproducibility (Text4: topics 2.2.7, 2.2.8).*

UNIT-II	**9 Hrs**

Force Systems: Types of forces- Coplanar, Concurrent and Parallel forces, Moment and couple, Free body diagram, Resultant of force systems, Resolution of forces, Composition of forces, Equilibrium equations of forces and Moment equilibrium equations

Friction: Introduction, Classification, Laws of friction, Coefficient of friction, Angle of friction, Ladder friction and Wedge friction

***Self Learning Topics (SLTs):** resolution of forces (Text5: topic 3.1), Solved problems (Text5: Prob 3.1, Prob 3.2, Prob 3.3), Solved problems (Text5: Prob 6.1 to 6.7).*

UNIT-III	**9 Hrs**

Centroid, Radius of gyration and Moment of Inertia: Centroid and Moment of inertia of figures like Rectangle, Circle and I-section

Applied Optics and Laser: Principles of interference, Diffraction phenomena and applications (qualitative); Difference between conventional light and laser, Basic principles and characteristics of lasers, Absorption, Spontaneous and stimulated emission, Population inversion, Pumping methods, Optical resonator; Types of lasers- Ruby laser, He-Ne Laser, Diode laser; Applications of lasers

***Self Learning Topics (SLTs):** centre of mass, centre of gravity (Text5: topics 4.1, 4.2), Solved problems (Text5: Prob 4.1, Prob 4.3), Einstein coefficients and their relation, metastable state (Text2: topics 44.3, 44.5).*

UNIT-IV	**9 Hrs**

Solar Photovoltaic Systems: Introduction, Solar cell fundamentals, Semiconductor materials- Classification, PN junction- Biasing, Break down, V-I characteristics; Photo voltaic effect-materials, Operation of a solar cell, Types of solar cells, Performance parameters of a single crystal solar cell- Short circuit current, Open circuit voltage, Fill factor and efficiency, I-V characteristics of solar cell and its effects based on insolation and temperature

Solar PV Module: Working principle of solar panels, Circuit diagram, Series and parallel connection of PV modules, Cell mismatch in a module, Solar array; PV systems for power generation- Stand alone and Grid alone PV systems, Applications- Street lighting, Water pumping, Refrigeration and telecommunications

***Self Learning Topics (SLTs):** Semiconductor principles (Text6: topic 15.3), Applications-Street lighting, Water pumping, Refrigeration and Tele communications (Text6: topic 15.10).*

Textbook(s):

1. V.D. Kodgire, *Material Science & Metallurgy,* 42nd ed., Pune: Everest Publishing House, 2018
2. M. Avadhanulu and Kshirsagar, TVS Arun Murthy, *A Text Book of Engineering Physics,* 11th ed., S. Chand & Company Ltd, 2018.
3. Rajesh K., Prasad, Ojha T. P., *Non-Conventional Energy Sources*, 4th ed., Jain Brothers, 2014

Reference Book(s):

1. D. S. Kumar, *Mechanical Measurements & Control,* 5th ed., Metropolitan Book Co. Pvt. Ltd, 2015
2. Tayal A.K., *Engineering Mechanics: Statics and Dynamics*, 14th ed., New Delhi: Umesh Publishers, 2014
3. G.D. Rai., *Solar Energy Utilization*, 5th ed., Khanna Publishers, 1997
4. D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, 10th ed., USA: Wiley, 2013

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc24_ph26/preview, *NPTEL video lecture on Solar Photovoltaics Fundamentals, Technology and Applications by Prof. Soumitra Satapathi, IIT Roorkee*
2. https://onlinecourses.nptel.ac.in/noc24_mm28/preview, *NPTEL video lecture on Defects in Crystalline Solids (Part - I) by Prof. Shashank Shekhar, IIT Kanpur*
3. https://onlinecourses.nptel.ac.in/noc24_ph45/preview, *NPTEL video lecture on Introduction to LASER by Prof. M. R. Shenoy, IIT Delhi*

Laboratory Manual (for laboratory component):

1. *Engineering Physics Laboratory Manual & Record Book,* Department of PS, KITSW
2. A.K.Katiyar, C.K.Pandey, *Engineering Physics Theory and Practical,* 2nd ed., Wiley India Pvt. Ltd., 2017

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1: draw and analyse crystal structures, imperfections in solids; list and define static and dynamic characteristics with examples

CO2: analyse various systems involving forces, moments and friction

CO3: determine moment of inertia of different objects and evaluate the properties of lasers

CO4: calculate the performance parameters of solar PV systems and explain its applications

Course Articulation Matrix (CAM):		**U24PY202A- ENGINEERING PHYSICS** (*for Mechanical Engineering)*												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24PY202A.1**	2	1	1	-	1	1	1	1	1	-	1	1	1
CO2	**U24PY202A.2**	2	1	-	-	-	1	1	1	1	-	1	1	1
CO3	**U24PY202A.3**	2	1	1	-	-	1	1	1	1	-	1	1	1
CO4	**U24PY202A.4**	2	1	1	1	-	1	1	1	1	1	1	1	1
	U24PY202A	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

ENGINEERING MATERIALS AND METALLURGY

Class: B. Tech. II -Semester		**Branch:** Mechanical Engineering	
Course Code:	**U24ME203**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: phase diagrams of binary alloys and iron-iron carbide equilibrium diagram

LO2: TTT diagrams and heat treatment processes

LO3: alloy steels, tool steels and powder metallurgy

LO4: materials testing methods and composites

UNIT-I	**9 Hrs**

Solidification, Solid solutions & Phase diagrams: Solidification of pure metals and alloys, nucleation and growth; Solid solutions - types, rules governing the formation of solid solutions and cooling curves

Phase diagrams: Basic terms, Gibb's phase rule, types of phase diagrams, construction of phase diagrams, interpretation of equilibrium diagrams - eutectic, eutectoid, peritectic & peritectoid, lever rule and problems on phase diagrams; Fe-Fe_3C equilibrium diagram

Self Learning Topics (SLTs): *Hume-Rothery's, rules of solid solubility (Text1: topics 5.2) and classifications and applications of steels and cast irons (Text1: topics 9.10)*

UNIT-II	**9 Hrs**

TTT diagrams: construction of TTT diagram of Eutectoid steel, superimposition of cooling curves on TTT diagram

Heat treatment processes: annealing, normalizing, hardening, tempering, martempering and austempering; effect of heat treatment processes on micro-structures and mechanical properties

Surface hardening : case hardening, carburizing, cyaniding, nitriding, Induction hardening and Age hardening

Self Learning Topics (SLTs): TTT diagram of hypo and hyper eutectoid steels *(Text1: topics 9.13)*

UNIT-III	**9 Hrs**

Alloy steels: Nickel steels, chromium steels, nickel-chromium steels, manganese steels, molybdenum steels, tungsten steel, vanadium steels and stainless steels

Tool Steels: Water-hardening tool steels, shock-resisting tool Steels, cold-worked tool steels, hot-work tool steels; cutting tools-types and applications

Introduction to smart materials, types and applications

Powder metallurgy: Introduction to powder metallurgy, powder fabrication methods**-** mechanical method, mechanical and electrolytic method, chemical method and atomization; characteristics of metal powders, powder packing, mixing and blending; sintering and applications of powder metallurgy

Self Learning Topics (SLTs): *Air hardening steels and high carbon high chromium steels(Text1: topics 10.7)*

UNIT-IV	**9 Hrs**

Destructive Testing: Tensile test, hardness tests- Brinell, Vickers and Rockwell; Impact tests-lzod and Charpy

Non-destructive Testing: Dye penetrant test, ultrasonic test, magnetic particle inspection and X–Ray radiography

Composite materials: Introduction, classification of composites, advantages and dis-advantages of composite materials, applications of composite materials; particle-reinforced composites, fiber-reinforced composites- carbon fiber–reinforced polymer composites; metal-matrix composites- Al and Cu matrix composites; ceramic-matrix composites

Self Learning Topics (SLTs): *compression test (Text1: topics 3.9),eddy current testing and visual inspection (Text1: topics 4.6 & 4.7)*

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1: construct phase diagram, Iron-Iron carbon diagram; classify steels and select them for given applications in engineering field

CO2: analyze isothermal transformation diagrams (TTT) and continuous cooling transformation diagrams (CCT)

CO3: analyze and select an appropriate alloy steel for a structural application

CO4: propose mechanical properties required for given engineering applications of materials; classify composites and select them for given applications in engineering.

Textbook(s):

1. Kodgirie. V. D. and Kodgirie S. V., *Material Science and Metallurgy*, 44th ed., Everest Publishing House, 2018.

Reference Book(s):

1. Avener S., *Introduction to Physical Metallurgy*, 2nd ed., Tata McGraw Hill Education (India) Pvt. Ltd., 2017.
2. Raghavan. V., *Material Science and Metallurgy*, 5th ed., PHI Learning Pvt. Ltd., 2013.
3. William D. Callister Jr & David G. Rethwisch, *Material Science Engineering*, Wiley, 10th ed., 2020.
4. Rajput R. K., *Material Science and Engineering*, 4th ed., S. K. Kataria & Sons, 2009.

(E-resources and other digital material)

Web and Video link(s):

1. Prof. R. N. Ghosh, IIT Kharagpur, Solidification Binary Alloys, Iron-Carbon Phase Diagram, https://www.youtube.com/results?search_query=prof.r.n+ghosh+lecturers
2. Prof. S. K. Gupta, IIT Delhi, Phase Diagrams, Crystal imperfections [English] Web Available: https://www.youtube.com/watch?v=x3n9ht-eRfg n
3. Prof. Ranjit Bauri Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Madras, Powder Metallurgy https://drive.google.com/file/d/1dG5kL2cLNs_4p3M5EM1s3yHRXTzUJUiQ/view
4. Prof. Bishakh Bhattacharya. Department of Mechanical Engineering, Smart Materials and Intelligent System Design. https://drive.google.com/file/d/1991bAO08h5Fd1NiWQb5iaYXI0wqnzw6l/view

Course Articulation Matrix (CAM):		**U24ME203 ENGINEERING MATERIALS AND METALLURGY**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME203.1**	2	1	1	-	-	-	1	1	1	1	1	1	1
CO2	**U24ME203.2**	2	1	1	-	-	-	1	1	1	1	1	1	1
CO3	**U24ME203.3**	2	2	1	-	-	-	1	1	1	1	1	1	1
CO4	**U24ME203.4**	2	2	1	1	-	-	1	1	1	1	1	1	1
U24ME203		**2**	**1.5**	**1**	**1**	**-**	**-**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

DATA STRUCTURES THROUGH C

Class: B.Tech. II –Semester		**Branch:** Common to all branches	
Course Code:	**U24ME204**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: time complexity, space complexity, array operations, and dynamic memory allocation
LO2: stacks and various forms of queues
LO3: various types of linked lists
LO4: various sorting techniques and hashing techniques

UNIT-I	**9 Hrs**

Data Structures: Basic terminology, Classification of data structures, Applications and operations on data structures, Time and space complexity

Arrays: Operations on arrays-traversing an array, Inserting an element in an array, Deleting an element from an array, Searching an element using binary search and their complexities,

Dynamic Memory Allocation: Memory allocation functions, Dynamic memory allocation for single and two dimensional arrays

Self Learning Topics (SLTs): *Three dimensional and n-dimensional arrays (Text1: topics 2.4.3), passing arrays to functions and pointers (Reference1: topics 3.6, 3.7), Practice problems (Text1: Prob 2.3, Reference1: Prob 1,Prob 2,Prob 3,Prob 4)*

UNIT-II	**9 Hrs**

Stacks: stacks, Array representation of stacks, Operations on a stack–push and pop; Multiple stacks, Applications of stacks- recursion, Fibonacci series, tower of Hanoi, evaluation of expressions (infix to postfix conversion, evaluation of postfix expression)

Queues: queues, Array representation of queues, Double ended queues, Circular queues

Self Learning Topics (SLTs): *Infix to prefix (Reference1: topics 7.7.3), priority Queue(Reference1: 8.4.3), Solved problems (Reference1: Prob 7.7.1, Prob 7.7.2), Practice problems (Text1: Prob 4.5, Prob 4.11, Prob 5.7, Prob 5.9)*

UNIT-III	**9 Hrs**

Linked Lists: Basic terminologies, Linked list versus arrays, Memory allocation and de-allocation for a linked list, Singly linked list, Circular linked list, Doubly linked list, Circular doubly linked list (linked list operations- traversing, searching, inserting, deleting), Representing stack and queue using linked list

Self Learning Topics (SLTs): *Merging (Text1: topics 3.3), Skiplist (weblink: https://www.geeksforgeeks.org/skip-list/), Deallocation strategy(Text1: topic 3.9), Solved problems (Text1: Prob 3.6.1, Prob 3.6.2), Practice problems (Reference1: Prob 5.5, Prob 5.7, Prob 5.9)*

UNIT-IV	**9 Hrs**

Sorting Techniques: Selection sort, Insertion Sort, Shell sort and radix sort, Time complexities of sorting

Hashing: Hashing techniques, Collision resolution techniques, Closed hashing, Open hashing, Comparison of collision resolution techniques

Self Learning Topics (SLTs): *Two way insertion sort (Text1: topics 10.3.4), Comparison of sorting techniques(Reference1: topics 14.16) Solved problems (Reference1: Prob 15.5, Prob 15.6, Prob 15.7), Practice problems (Text1: Prob 6.4)*

Textbook(s):

1. Debasis Samanta, *Classic Data Structures*, 2nd ed., Prentice Hall India, 2009

Reference Book(s):

1. Reema Thareja, *Data Structures Using C*, 2nd ed., Oxford University Press, 2014
2. Balagurusamy E, *Data Structure Using C*, 1st ed., McGraw Hill Education, 2017
3. Richard F. Gilberg and Behrouz A. Forouzan, *Data Structures: A Pseudocode Approach with C*, 2nd ed., Cengage Learning, 2007

Web and Video link(s):

https://nptel.ac.in/courses/106106130; *NPTEL Video Lecture on Programming and Data Structures Dr. N. S. Narayana Swamy, CSE, IIT Madras.*

Laboratory Manual (for laboratory component):

1. *Data Structures through C Laboratory Manual and Record Book,* Department of CSE (AI & ML), KITSW.

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1:	analyze and implement array operations by utilizing dynamic memory allocation and evaluating their time and space complexities
CO2:	analyze and implement stack and queue data structures by utilizing array representations and evaluating their applications and operational complexities
CO3:	analyze and implement various types of linked lists by utilizing dynamic memory allocation techniques and evaluating their operational complexities
CO4:	develop various sorting algorithms, analyze their time complexities, and apply hashing techniques with collision resolution methods, comparing their efficiencies

Course Articulation Matrix (CAM):		**U24ME204 DATA STRUCTURES THROUGH C**											
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME204.1**	2	2	2	1	-	-	1	1	1	1	1	1	2
CO2	**U24ME204.2**	2	2	2	2	-	-	1	1	1	1	2	1	2
CO3	**U24ME204.3**	2	2	2	2	-	-	1	1	1	1	2	1	2
CO4	**U24ME204.4**	2	2	2	2	-	-	1	1	1	1	2	1	2
U24ME204		**2**	**2**	**2**	**1.75**	**-**	**-**	**1**	**1**	**1**	**1**	**1.75**	**1**	**1.5**

BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

Class: B.Tech. II -Semester		**Branch:** Common to CE & ME	
Course Code:	U24EE205A	**Credits**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: network elements and DC circuits
LO2: 1- Ø AC and 3-Ø AC circuits
LO3: construction, operating principles & applications of DC & AC machines and renewable energy sources
LO4: concepts of diodes, rectifiers and transistors

UNIT-I	**9 Hrs**

DC circuits: Network elements, Linear & non-linear elements, Active & passive elements, Unilateral & bilateral elements, Ohm's law, Power, Energy, Kirchhoff's laws, Resistances connected in series and parallel, Voltage divider rule & Current divider rule.

DC Circuit analysis: Source transformation, Mesh analysis & Nodal analysis.

Self-Learning Topics (SLTs)*: Definitions of charge, current, & voltage (Text1: Topics1.2,), Solved problems (Text1: Prob 3.10, 3.11 & 3.12), Practice problems (Text1: Chap-3, Prob 4,5,7&8).*

UNIT-II	**9 Hrs**

1-Ø **AC circuits:** R.M.S value, Average value, Peak factor and form factor of a sine wave, Concept of phasor, Phase and phase difference, Rectangular and polar form representation, Sinusoidal steady state analysis of R, L, C, Series RL, RC, RLC circuits, Concept of reactance, Impedance, Complex power, Real power, Reactive power and Power factor.

3- Ø **AC circuits**: Generation of 3**-** Ø voltages, Advantages, Disadvantages, Applications of three phase system, Voltage &Current relationships of line and phase values for balanced star and delta connections.

Self-Learning Topics (SLTs): *Expression for RMS & Average value (Text1: Topic, 4.4 & 4.5) Solved problems (Text1: Prob 4.10, 4.12, 4.13 & 4.14), Practice problems (Text1: Chap-4,Prob 8,9,10 & 12).*

UNIT-III	**9 Hrs**

Electrical Machines and Renewable Energy Sources (Qualitative treatment):
Construction, Principle of operation, characteristics & applications of 1- Ø transformer, 3- Ø induction motor, 1- Ø induction motor, DC motor, Stepper motor, and BLDC motor

Renewable Energy Sources: Solar Photovoltaic, Wind, Waste to energy & Bioenergy

Self-Learning Topics (SLTs): *EMF equation of a Transformer (Text1: Part-II Topic, 4.4.2) Solved problems (Text1: Part-II Prob 4.5, 4.6 & 4.7), Practice problems (Text1: Part-II Prob 5.2, 5.3 & 5.4), Practice problems (Text1: Part-II Prob 6, 7 & 8)*

UNIT-IV	**9 Hrs**

Electronic Devices and Circuits:
P-N Junction diode, volt-amp characteristics, Zener diode, volt-amp characteristics, Half-wave rectifier and Full-wave rectifier (centre tapped), Bi-polar Junction Transistor-symbol, Construction and operation of N-P-N and P-N-P transistors, Characteristics of BJT (CE, CB & CC configurations), Applications of diodes and transistors for civil and mechanical engineers.

Self-Learning Topics (SLTs): C*lassification of Semiconductors (Text2: topics 1.2), Solved problems (Text2: Prob 1.2,), Zener diode Applications (Text2: 1.15), Solved problems (Text2: Prob 2.1 & 2.4), Types of transistors (Text2: topics 3.5)*

Textbook(s):

1. K. Uma Rao, *Basic Electrical Engineering*, Pearson Education, 2011 (Unit-I, II & III)
2. S Salivahanan & N Suresh Kumar , *Electronic Devices and Circuits*, 5th ed., Tata McGraw Hill (Unit -IV)

Reference Book(s):

1. B.L.Thereja, A.K.Thereja, *Electrical Technology Vol. I & II* , S.Chand & Company Ltd, 2005.
2. Edward Hughes, *Electrical & Electronics Technology*, 10th ed., Pearson Education, 2010.
3. D. P. Kothari and I. J. Nagrath, *Basic Electrical Engineering*, Tata McGraw Hill, 2010.
4. Chakravarthy A, Sudhipanath and Chandan Kumar, *Basic Electrical Engineering*, Tata McGraw Hill Ltd., 2009.

Web and Video link(s):

https://nptel.ac.in/courses/108/105/108105112//; *NPTEL Video Lecture on Fundamentals of Electrical Engineering by Prof. Debapriya Das, Professor of EED, IITK Kharagpur.*

Laboratory Manual (for laboratory component):

1. *Basic Electrical & Electronics Engineering Laboratory Manual and Record Book,* Department of EEE, KITSW.

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1: determine voltage, current & power in electrical circuits using network reduction techniques

CO2: determine impedance, voltage, current, and power in 1- Ø AC circuits & determine line and phase quantities in 3- Ø AC circuits

CO3: select a suitable electrical machine for the given applications

CO4: determine the voltage and current characteristics of diodes and transistors

Course Articulation Matrix (CAM):		**U24EE205A : BASIC ELECTRICAL & ELECTRONICS ENGINEERING**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24EE205A.1**	2	1	-	-	-	-	1	1	1	1	**1**	2	1
CO2	**U24EE205A.2**	2	2	-	-	-	-	1	1	1	1	**1**	2	1
CO3	**U24EE205A.3**	3	3	1	1	1	1	1	1	1	1	**1**	2	1
CO4	**U24EE205A.4**	3	3	1	1	1	1	1	1	1	1	**1**	2	1
U24EE205A		**2.5**	**2.25**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	1
3 – HIGH, 2 – MEDIUM, 1 – LOW														

ENVIRONMENTAL STUDIES

Class: B. Tech. II Semester		**Branch:** Common to ME, CSM, CSD, IT, CSN & CSO	
Course Code:	**U24CY206**	**Credits:**	**-**
Hours/Week(L-T-P-O-E):	**2-0-0-2-4**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24Hrs**	**ESE:**	**40%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in/on…

LO1:natural resources and their usage more equitably

LO2: ecosystem and the importance of biodiversity conservation

LO3: environmental pollution and it'scontrol measures

LO4:environmental legislation and green methodology

UNIT-I	**6Hrs**

The Multidisciplinary Nature of Environmental Studies: Definition, Scope and importance

Natural Resources: Forest Resources-Use and overexploitation of forests, Deforestation, Timber extraction, Mining, Dams and their effects on forests and tribal people**;** Water Resources-Use and over-utilization of surface and ground water, Floods, Drought, Conflicts over water**;** Mineral Resources-Environmental effects of extracting and using mineral resources**;** Energy Resources-Renewable and non-renewable energy sources, Use of alternate energy sources

Self-Learning Topics (SLTs): *Use and over-utilization of surface and ground water(Text1: unit 2, topic: 2.2.2) world food problems(Text1: unit 2, topic 2.2.2)*

UNIT-II	**6Hrs**

Ecosystem and Biodiversity:

Ecosystem: Concepts of an ecosystem, Food chain, Food webs, Ecological pyramids, Energy flow in the ecosystem and ecological succession

Biodiversity and its Conservation: Introduction, Definition, Genetic, Species and ecosystem diversity, Value of biodiversity, Biodiversity in India, Hot spots of biodiversity, Man-wildlife conflicts, Endangered and endemic species of India; In-situ and Ex-situ conservation

Self-Learning Topics (SLTs): *Introduction and definition of biodiversity (Text1: unit 4, topic 4.1)*

UNIT-III	**6Hrs**

Environmental Pollution: Global issues**-**Global climatic change, Greenhouse gases, Effects of global warming, Ozone layer depletion

International Conventions/Protocols: Earth summit, Kyoto protocol, Montreal protocol

Environmental Pollution-Causes and effects of air, Water, Soil, Marine and noise pollution with case studies

Solid and Hazardous Waste Management: Introduction, Types, Effects of urban industrial and nuclear waste

Natural Disaster Management: Introduction to disaster, Management of disaster, Disaster management of flood, earthquake, cyclone and landslides

Role of information technology in environment and human health

Self-Learning Topics (SLTs): *Role of individual in prevention of pollution (Text1: unit 5, topic 5.10)*

UNIT-IV	**6Hrs**

Social Issues and the Environment: Role of Individual and Society, Water conservation, Rain water harvesting

Environmental Protection/Control Acts: Air (prevention and control of pollution) act 1981, Forest conservation act (1980 and 1992), Wildlife protection act 1972, Environment protection act 1986, Issues involved in enforcement of environmental legislations

Green Methodology: Principles of green chemistry, Green methods in electronic production, Impact of electronic waste on public health and environment;United nations goals of sustainable development

Self-Learning Topics(SLTs):*Water (prevention and control of pollution) act 1974(Text1: unit 6, topics 6.10), Water pollution cess act 1977(Text1: unit 6, topics 6.11)*

Textbook(s):

1. Erach Bharucha,*Text Book of Environmental Studies for Under Graduate Courses,* 2nd ed., Universities Press (India)Pvt. Ltd., 2013.

Reference Book(s):

1. Y. Anjaneyulu, *Introduction to Environmental Science*, B.S. Publications, 2004.
2. Gilbert M. Masters, *Introduction to Environmental Engineering & Science*, 3rd ed., Prentice Hall of India, 1991
3. Anubha Kaushik, C.P. Kaushik, *Environmental Studies*, 4th ed., New Age International Publishers, 2014
4. R.Rajagopalan, *Environmental Studies from crisis to cure*, 2nd ed., Oxford University Press, 2011

Weband Videolink(s):

1. https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch27/ *videolecture on renewable energy resources by Prof. Vaibhav. V. Goud and Dr. R. Anandalakshmi, Dept. Of Chemical Engineering, Guwahati.*

CourseLearningOutcomes(COs):

After completion of this course, the students should be able to,

CO1: identify the natural resources and practice their usage more equitably

CO2: develop an action plan for sustainable alternatives and conserving biodiversity

CO3: examine and perceive the solutions for the environmental pollution

CO4:adapt issues involved in enforcement of environmental legislation and green methodology

Course Articulation Matrix (CAM):		**U24CY206 ENVIRONMENTAL STUDIES**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24CY206.1**	2	1	2	1	-	2	-	1	-	1	-	-	-
CO2	**U24CY206.2**	-	-	2	-	-	2	-	1	-	1	-	1	-
CO3	**U24CY206.3**	1	2	1	-	-	1	1	1	-	1	-	1	-
CO4	**U24CY206.4**	-	-	1	-	-	2	-	1	-	1	-	-	-
U24CY206		**1.5**	**1.5**	**1.5**	**1**	**-**	**1.75**	**1**	**1**	**-**	**1**	**-**	**1**	**-**
3–HIGH,2–MEDIUM,1-LOW														

IDEA Lab Makerspace

Class: B.Tech. II -Semester		**Branch:** Common to all branches	
Course Code:	**U24AE207**	**Credits:**	**1**
Hours/Week (L-T-P-O-E):	**0-0-2-2-4**	**CIE :**	**60%**
Total Number of Lab Hours:	**36 Hrs**	**ESE :**	**40%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: carpentry and CNC wood router
LO2: mould for sand casting and arc welding joints
LO3: laser engraving, 3D printing and robots in manufacturing
LO4: Printed Circuit Board (PCB) and Internet of Things (IoT)

LABORATORY COMPONENT

S. No.	Creative Fabrication Technology	List of Experiments
1.	Carpentry	Prepare a half lap dovetail joint
2.	CNC Wood Router	Perform wood carving using CNC Wood Router
3.	Foundry	Prepare a sand mould using single piece pattern
4.	Welding	Prepare a single V-butt joint on mild steel plates using AC arc welding machine
5.	Injection Moulding	Prepare a plastic product using Injection moulding machine
6.	Laser Engraving	Perform key chain by using CO_2 laser cutting machine
7.	3D Printing	Prepare a key chain on 3D printer with the given dimensions
8.		Prepare a Spur Gear on 3D printer with the given dimensions
9.	Robotics	Perform basic pick-and-place operation using robot
10.	Printed Circuit Board (PCB)	Design and fabricate a PCB for a given application
11.	Internet of Things (IoT)	Measure the temperature and humidity by using DHT11 sensor and Arduino UNO
12.		Create a smart plant watering system using IoT
Course Project		• Students are required to create an affordable prototype as their course project, based on the knowledge and skills acquired during the course. • Students have to present and submit their prototypes to demonstrate their ability to apply classroom learning practically, showcasing their creativity and technical aptitude.

Laboratory Manual:

- ***IDEA Lab Makerspace*** *Laboratory Manual & Record Book (LMRB)* prepared by the faculty of department of Mechanical Engineering, KITSW, Revised version 4, August-2024.

Text/ Reference Book(s):

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy., "*Elements of Workshop Technology*", Vol-I-2008 &Vol-II-2010, Media Promoters and publishers Pvt. Ltd, India,

2. Ian Gibson, David Rosen, Brent Stucker, Mahyar Khorasani, "*Additive Manufacturing Technologies-3D Printing, Rapid Prototyping, and Direct Digital Manufacturing*" 2nd ed., Springer Nature, 2021.
3. R.S. Khandpur, "*Printed Circuit Boards: Design, Fabrication, Assembly and Testing*", New Delhi: Tata Mc Graw Hill-2008.
4. Sudeep Mishra, Anandarupmukherjee and Arijit Roy, "*Introduction to IoT*", New Delhi: University Cambridge Press, 2021.

Course Learning Outcomes (COs):

After completion of this course, the students should be able to …

(based on psychomotor skills acquired from laboratory component)

CO1: produce wooden joints and intricate articles using carpentry and CNC wood router respectively

CO2: implement procedures to prepare the mould cavity for sand casting and arc welding joints

CO3: produce innovative prototypes using laser engraving and 3D printing

CO4: design and develop systems based on PCB and IoT for given applications

Course Articulation Matrix (CAM):		**U24AE207 IDEA Lab Makerspace**											
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24AE207.1**	2	2	1	1	2	1	1	2	2	1	1	1	2
CO2	**U24AE207.2**	2	2	1	1	2	1	1	2	2	1	1	1	2
CO3	**U24AE207.3**	2	2	1	1	2	1	1	2	2	1	1	1	2
CO4	**U24AE207.4**	2	2	1	1	2	1	1	2	2	1	1	1	2
	U24AE207	**2**	**2**	**1**	**1**	**2**	**1**	**1**	**2**	**2**	**1**	**1**	**1**	**2**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

ENGINEERING PHYSICS LABORATORY			
Class: B.Tech. II -Semester		**Branch:** ME	
Course Code:	**U24PY209A**	**Credits:**	**1**
Hours/Week (L-T-P-E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: crystal structure, imperfections in solids and instrument characteristics
LO2: force systems, concepts and applications of friction
LO3: centroid, moment of inertia of different objects and operation of lasers
LO4: V-I characteristics, materials performance and applications of solar PV systems

List of Experiments

1. Determination of the linear measurements using Vernier callipers and screw gauge
2. Preparation and study of body centred cubic and face centred cubic crystal models
3. Determination of (a) rigidity modulus of a given wire (b) moment of inertia of a ring using torsional pendulum
4. Radius of gyration (k) and acceleration due to gravity(g) using compound pendulum
5. Determination of the radius of gyration of given bar using Bi-Filar suspension
6. Determination of force constant of a spiral spring using static method
7. Determination of coefficient of friction using pin on disc machine
8. Determination of slit width using He-Ne laser
9. Determination of wavelength of He-Ne laser-using reflection and transmission diffraction grating
10. Performance parameters of a solar PV module
11. I-V characteristics of a solar PV module connected in series and parallel
12. Performance study of solar PV panel with surrounding temperature and intensity

Textbook(s):

1. V.D. Kodgire, *Material Science & Metallurgy,* 42nd ed., Pune: Everest Publishing House, 2018
2. M. Avadhanulu and Kshirsagar, TVS Arun Murthy, *A Text Book of Engineering Physics,* 11th ed., S. Chand & Company Ltd, 2018.
3. Rajesh K., Prasad, Ojha T. P., *Non-Conventional Energy Sources*, 4th ed., Jain Brothers, 2014

Reference Book(s):

1. D. S. Kumar, *Mechanical Measurements & Control,* 5th ed., Metropolitan Book Co. Pvt. Ltd, 2015
2. Tayal A.K., *Engineering Mechanics: Statics and Dynamics*, 14th ed., New Delhi: Umesh Publishers, 2014
3. G.D. Rai., *Solar Energy Utilization*, 5th ed., Khanna Publishers, 1997
4. D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, 10th ed., USA: Wiley, 2013

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc24_ph26/preview, *NPTEL video lecture on Solar Photovoltaics Fundamentals, Technology and Applications by Prof. Soumitra Satapathi, IIT Roorkee*
2. https://onlinecourses.nptel.ac.in/noc24_mm28/preview, *NPTEL video lecture on Defects in Crystalline Solids (Part - I) by Prof. Shashank Shekhar, IIT Kanpur*
3. https://onlinecourses.nptel.ac.in/noc24_ph45/preview, *NPTEL video lecture on Introduction to LASER by Prof. M. R. Shenoy, IIT Delhi*

Laboratory Manual (for laboratory component):

1. *Engineering Physics Laboratory Manual & Record Book,* Department of PS, KITSW
2. A.K.Katiyar, C.K.Pandey, *Engineering Physics Theory and Practical,* 2nd ed., Wiley India Pvt. Ltd., 2017

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1: measure diameter of wire using Vernier callipers and screw gauge, rigidity modulus of wire and prepare BCC and FCC crystal models

CO2: determine coefficient of friction using pin on disc machine, radius of gyration (k) of a bar and force constant of a spiral spring

CO3: determine the width of a narrow slit and wavelength of laser using diffraction phenomenon

CO4: analyze I-V characteristics and performance of a solar PV module systems

Course Articulation Matrix (CAM):		**U24PY209A- ENGINEERING PHYSICS LABORATORY**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24PY209A.1**	2	1	-	-	1	1	1	1	2	-	1	1	1
CO2	**U24PY209A.2**	2	1	-	-	1	1	1	1	2	-	1	1	1
CO3	**U24PY209A.3**	2	1	-	-	1	1	1	1	2	-	1	1	1
CO4	**U24PY209A.4**	2	1	1	1	1	1	1	1	2	1	1	1	1
	U24PY209A	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1.5**	**1**	**1**	**1**	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

DATA STRUCTURES THROUGH C LABORATORY			
Class: B.Tech. II –Semester		**Branch:** Common to all branches	
Course Code:	**U24ME210**	**Credits:**	**1**
Hours/Week (L-T-P-E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: time complexity, space complexity, array operations, and dynamic memory allocation
LO2: stacks and various forms of queues
LO3: various types of linked lists
LO4: various sorting techniques and hashing techniques

List of Experiments

Experiment-I

1. Program to implement initialization of array and perform traversal operations in both the directions
2. Program to implement searching operation on array using Linear Search
3. Program to display the count of occurrences of every number in an array

Experiment-II

4. Program to implement searching operation on array using Binary Search
5. Program to implement insertion operation on array
6. Program to implement deletion operations on array

Experiment-III

7. Program to implement initialization of arrays and traversal operation with DMA
8. Program to implement matrix addition and subtraction with DMA

Experiment-IV

9. Program to implement matrix multiplication with DMA
10. Program to implement stack operations
11. Program to convert infix expression into postfix

Experiment-V

12. Program to evaluate given postfix expression
13. Program to define recursive function to solve tower of hanoi puzzle
14. Program to display the Fibonacci series with the help of recursive function
15. Program to implement MultiStack

Experiment-VI

16. Program to implement queue operations using arrays
17. Program to implement circular queue operations using arrays
18. Program to implement double ended queue operations using arrays

Experiment-VII

19. Program to create single linked list and implement its operations

Note:- Linked list Operations**:** i) traversing ii) inserting iii) deleting iv) searching v) reversing vi) concatenation

Experiment-VIII

20. Program to create circular linked list and implement its operations
21. Program to create double linked list and implement its operations

Experiment-IX

22. Program to create circular double linked list and implement its operations

Experiment-X

23. Program to implement stack operations using linked list
24. Program to implement queue operations using linked list

Experiment-XI

25. Program to implement selection sort
26. Program to implement insertion sort

Experiment-XII

27. Program to implement shell sort
28. Program to implement radix sort
29. Program to implement hash table.

Textbook(s):

1. Debasis Samanta, *Classic Data Structures*, 2nd ed., Prentice Hall India, 2009

Reference Book(s):

1. Reema Thareja, *Data Structures Using C*, 2nd ed., Oxford University Press, 2014
2. Balagurusamy E, *Data Structure Using C*, 1st ed., McGraw Hill Education, 2017
3. Richard F. Gilberg and Behrouz A. Forouzan, *Data Structures: A Pseudocode Approach with C*, 2nd ed., Cengage Learning, 2007

Web and Video link(s):

https://nptel.ac.in/courses/106106130; *NPTEL Video Lecture on Programming and Data Structures Dr. N. S. Narayana Swamy, CSE, IIT Madras.*

Laboratory Manual (for laboratory component):

1. *Data Structures through C Laboratory Manual and Record Book,* Department of CSE (AI & ML), KITSW.

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1: develop and test basic data structures and array operations, including dynamic memory allocation to evaluate their performance and complexity

CO2: apply the linear data structures such as stacks and queues and perform various operations using LIFO or FIFO order respectively

CO3: solve problems using various linked list representations for efficiently storing and retrieving the data

CO4: apply different sorting techniques on unsorted data and sort them in an order, able to store the data using hashing techniques to retrieve the data very effectively

Course Articulation Matrix (CAM):		**U24ME210 DATA STRUCTURES THROUGH C LABORATORY**											
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME210.1**	2	2	2	1	-	-	1	1	1	1	1	1	1
CO2	**U24ME210.2**	2	2	2	2	-	-	1	1	1	1	2	1	1
CO3	**U24ME210.3**	2	2	2	2	-	-	1	1	1	1	2	1	1
CO4	**U24ME210.4**	2	2	2	2	-	-	1	1	1	1	2	1	1
U24ME204		**2**	**2**	**2**	**1.75**	**-**	**-**	**1**	**1**	**1**	**1**	**1.75**	**1**	**1.5**

BASIC ELECTRICAL & ELECTRONICS ENGINEERING LABORATORY			
Class: B.Tech. II -Semester		**Branch:** Common to CE & ME	
Course Code:	U24EE211A	**Credits**	**1**
Hours/Week (L-T-P -E):	**0-0-2-2**	**CIE**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: network elements and DC circuits
LO2: 1- Ø AC and 3-Ø AC circuits
LO3: construction, operating principles & applications of DC & AC machines and renewable energy sources
LO4: concepts of diodes, rectifiers and transistors

List of Experiments

1. Verification of voltage divider rule and current divider rule
2. Verification of Mesh Analysis
3. Verification of Nodal Analysis
4. Determination of internal parameters of a choke coil
5. Impedance calculations and phasor representation of RL series circuit
6. Impedance calculations and phasor representation of RC series circuit
7. Load test on 1-phase transformer
8. Single phase bridge rectifier using R load
9. Zener diode as voltage regulator
10. Input and output characteristics of BJT
11. Verification of Kirchoff's laws using PSPICE/MATLAB
12. **Interfacing Sensors with Arduino using TINKER CAD**
    i. LED blinking
    ii. IR Sensor
    iii. Ultrasonic Sensor
    iv. Voltage Sensor
    v. Current Sensor
    vi. Speed Sensor

Textbook(s):

1. K. Uma Rao, *Basic Electrical Engineering*, Pearson Education, 2011 (Unit-I, II & III)
2. S Salivahanan & N Suresh Kumar , *Electronic Devices and Circuits*, 5th ed., Tata McGraw Hill (Unit -IV)

Reference Book(s):

1. B.L.Thereja, A.K.Thereja, *Electrical Technology Vol. I & II* , S.Chand & Company Ltd, 2005.
2. Edward Hughes, *Electrical & Electronics Technology*, 10th ed., Pearson Education, 2010.
3. D. P. Kothari and I. J. Nagrath, *Basic Electrical Engineering*, Tata McGraw Hill, 2010.
4. Chakravarthy A, Sudhipanath and Chandan Kumar, *Basic Electrical Engineering*, Tata McGraw Hill Ltd., 2009.

Web and Video link(s):

https://nptel.ac.in/courses/108/105/108105112//; *NPTEL Video Lecture on Fundamentals of Electrical Engineering by Prof. Debapriya Das, Professor of EED, IITK Kharagpur.*

Laboratory Manual (for laboratory component):

1. *Basic Electrical & Electronics Engineering Laboratory Manual and Record Book,* Department of EEE, KITSW.

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1: validate mesh and nodal analysis

CO2: determine the impedance of series RL & RC circuits

CO3: determine the efficiency of a transformer by conducting a load test and verify Kirchhoff's laws using PSPICE

CO4: determine the characteristics of BJT and determine the parameters of a rectifier circuit

Course Articulation Matrix (CAM):		**U24EE211A : BASIC ELECTRICAL & ELECTRONICS ENGINEERING LOBORATORY**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24EE211A.5**	2	1	-	-	-	-	1	1	1	1	**1**	2	1
CO2	**U24EE211A.6**	2	2	-	-	-	-	1	1	1	1	**1**	2	1
CO3	**U24EE211A.7**	3	3	1	1	1	1	1	1	1	1	**1**	2	1
CO4	**U24EE211A.8**	3	3	1	1	1	1	1	1	1	1	**1**	2	1
U24EE211A		**2.5**	**2.25**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	1
3 – HIGH, 2 – MEDIUM, 1 – LOW														

INTERNAL COMBUSTION ENGINES			
Class: B. Tech. II –Semester (Exit)		**Branch:** ME	
Course Code:	**U24ME212X**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-0-2-4**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**32 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: Classification, components and nomenclature of an IC Engine

LO2: valve timing diagram of SI and CI engines

LO3: performance parameters of an IC engine

LO4: fuel supply systems of an IC engine

THEORY COMPONENT

UNIT-I	**4 Hrs**

IC Engines: Basic engine components and nomenclature; classification of engines; Working principle of two and four stroke SI & CI engines, Valve and port timing diagrams of IC engines

UNIT-II	**4 Hrs**

Testing of IC Engines: Measurement of brake power, friction power and indicated power; indicator diagram, fuel and air consumption

UNIT-III	**4 Hrs**

IC Engine Characteristics: Mean effective pressure, specific fuel consumption, air-fuel ratio, mechanical, volumetric and thermal efficiencies, effect of clearance volume on volumetric efficiency, Heat balance sheet

UNIT-IV	**4 Hrs**

Fuel Supply Systems: SI Engines - carburetion, mixture requirements; calculation of air fuel ratio; types of carburetors; CI Engines - functional requirements of an injection system, injection pump and injector nozzle

LABORATORY COMPONENT

List of Experiments

1. Load test on conventional single-cylinder four-stroke Compression Ignition Engine with Brake Drum Dynamometer.
2. Heat Balance test on conventional single-cylinder four-stroke Compression Ignition Engine with Brake Drum Dynamometer.
3. Load test on conventional twin-cylinder, four-stroke Compression Ignition engine with hydraulic dynamometer.
4. Heat balance test conventional twin-cylinder, four-stroke, Compression Ignition engine with hydraulic dynamometer
5. Performance test on single-cylinder, four-stroke Compression Ignition engine with eddy current dynamometer with Variable Compression Ratio.
6. Valve Timing Diagram of a single-cylinder four-stroke, Compression Ignition Engine.
7. Morse test on four-stroke, four-cylinder Spark Ignition Engine.
8. Performance test on computer-aided single-cylinder four-stroke, Compression Ignition Engine with eddy current Dynamometer.

Textbook(s):

1. Ganesan V., *Internal Combustion Engines*, 4th ed., New Delhi: Tata McGraw-Hill, 2013. *(Chapters 1, 2,15,16)*
2. Mahesh M Rathore, *Thermal Engineering*, New Delhi: Mc Graw Hill, 2010.

Reference Book(s):

1. Heywood J.B., *Internal Combustion Engine Fundamentals*, revised edition, New Delhi: McGraw-Hill, 1988.
2. Colin Ferguson R., Allan Kirkpatrick T., *Internal Combustion Engines: Applied Thermo sciences*, 2nd ed., New Delhi: Wiley, 2001.
3. Gupta H.N., *Fundamentals of Internal Combustion Engines*, 2nd ed., New Delhi: PHI Pvt. Ltd., 2012.

4. Rajput R.K., *Text book on Internal Combustion Engines*, New Delhi: Laxmi publication Pvt. Ltd., 2013.

Web and Video link(s):

https://archive.nptel.ac.in/courses/112/103/112103262/; *NPTEL Video Lecture on IC Engines by Prof. Pranab K. Modal, Professor of ME, IIT Guwahati & Prof. Vinayak N Kulkarni, Professor of ME, IIT Guwahati.*

Laboratory Manual (for laboratory component):

1. *IC Engines laboratory manual,* Department of ME, KITSW

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from theory component)

CO1: compare SI and CI Engines
CO2: evaluate the performance parameters
CO3: solve the numerical problems on IC engines Characteristics
CO4: analyse the fuel supply systems for SI and CI engines

(based on knowledge acquired from laboratory component)

CO5 : analyse characteristics of an SI engine
CO6 : evaluate performance Characteristics of an CI engine
CO7 : draw the valve timing diagram of a CI engine
CO8 : draw the heat balance sheet of an IC engine

Course Articulation Matrix (CAM)		**U24ME212X INTERNAL COMBUSTION ENGINES**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME212X.1**	-	-	1	-	-	1	1	1	1	1	1	1	1
CO2	**U24ME212X.2**	-	-	1	-	-	1	1	1	1	1	1	1	1
CO3	**U24ME212X.3**	1	2	1	-	2	1	1	1	1	1	1	1	1
CO4	**U24ME212X.4**	1	2	1	-	2	1	1	1	1	1	1	1	1
CO5	**U24ME212X.5**	-	-	1	-	-	1	1	1	1	1	1	1	1
CO6	**U24ME212X.6**	-	-	1	-	-	1	1	1	1	1	1	1	1
CO7	**U24ME212X.7**	1	2	1	-	2	1	1	1	1	1	1	1	1
CO8	**U24ME212X.8**	1	2	1	-	2	1	1	1	1	1	1	1	1
U24ME212X		**1**	**2**	**1**	**-**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

MACHINE DRAWING AND MODELLING			
Class: B.Tech. II-Semester (Exit)		**Branch:** ME	
Course Code:	**U24ME213X**	**Credits:**	**03**
Hours/Week (L-T-P-E):	**2-0-2-4**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**32 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: conventions, limits, fits & tolerances used in machine drawing.
LO2: screw threads, bolts, nuts and keys
LO3: cotter joint, revolving centre and types of couplings.
LO4: riveted joints, bearings and screw jack

THEORY COMPONENT

UNIT-I	**4 Hrs**

Introduction: Classification of machine drawings, Conventional representation- Materials, Springs, Welded joints, Gears, Machine components and Surface roughness; Limits, Fits and Tolerances- Introduction, representation of fits, hole and shaft basis systems

UNIT-II	**4 Hrs**

Machine Elements: Screw fastening - Screw thread nomenclature, Types of thread profiles; Bolted joints- Hexagonal headed bolt with nut and washer, studded joint; Nuts- Lock nut, castle nut, wile"s lock nut; Foundation bolts- eye foundation bolt; Keys- Representation of saddle key, sunk keys.

UNIT-III	**4 Hrs**

Cotter joints- Cotter joints with sleeve, knuckle joint; **Couplings**- Flexible couplings types of flanged couplings; **Non-aligned couplings**-Universal coupling, Oldham's coupling; Revolving Center.

UNIT-IV	**4 Hrs**

Riveted joint-Types of riveted joints and rivet heads; **Bearings**- Solid journal bearing, bushed journal bearing, Plummer block, collar thrust bearing, foot step bearing, Anti-friction bearings; Screw Jack.

LABORATORY COMPONENT

List of Experiments

1. Draw the Conventional representation of Welded Joints and Materials; introduction to AUTOCAD software-GUI, Settings, Standard toolbar, toolbars - DRAW, MODIFY, DIMENSION and PROPERTIES, design centre and tool palettes
2. Draw the diagram illustrating basic size deviations and tolerances.
3. Draw the different types of Screw thread profiles
4. Draw a hexagonal headed bolt with a nut and a washer in position, Eye foundation bolt.
5. Draw the Assembly of KNUCKLE JOINT
6. Draw the part drawing of Revolving Center
7. Draw the Assembly of BUSHED BEARING.
8. Draw the Assembly of SCREW JACK.

Text book(s):

1. Siddheshwar, Kannaiah and Sastry, *Machine Drawing*, 48th reprint ed., New Delhi: McGraw-Hill Education Pvt. Ltd., 2014.

Reference Book(s):

1. Narayana, Venkat Reddy and Kannaiah, *Machine Drawing*, 3rd ed., New Age International, 2009.
2. Bhatt N. D. and Panchal V. M., *Machine Drawing*, 46th ed., Charotar Publishing House, 2011.

Web and Video link(s):
https://onlinecourses.swayam2.ac.in/aic22_ts41/preview Engineering drawing and computer graphics in Telugu, SWAYAM-NPTEL lecture by Prof. Rajaram Lakkaraju, IIT Kharagpur

Laboratory Manual (for laboratory component): *Modelling Laboratory Manual,* Department of Mechanical Engineering, KITSW.

Course Learning Outcomes (COs): Course Learning Outcomes (COs):
After completion of this course, the students should be able to,

CO1: apply the conventions, limits, fits & tolerances in machine drawing
CO2: draw screw threads, bolts, nuts and keys
CO3: draw sectional views of cotter joint and couplings
CO4: draw sectional views of riveted joints and bearings

(based on skills acquired from laboratory component)

CO5: apply the conventions, limits, fits & tolerances in machine drawing
CO6: draw screw thread profiles and bolted joints
CO7: assemble knuckle joint and draw part drawing of revolving center
CO8: draw the assembly of bushed bearing and screw jack

Course Articulation Matrix (CAM):		**U24ME213X MACHINE DRAWING AND MODELLING**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME213X.1**	2	1	-	-	-	1	1	1	1	1	1	1	1
CO2	**U24ME213X.2**	2	1	-	-	-	1	1	1	1	1	1	1	1
CO3	**U24ME213X.3**	2	1	-	-	-	1	1	1	1	1	1	2	1
CO4	**U24ME213X.4**	2	1	-	-	-	1	1	1	1	1	1	2	-
CO5	**U24ME213X.5**	2	1	-	-	1	1	1	1	1	1	1	1	1
CO6	**U24ME213X.6**	2	1	-	-	1	1	1	1	1	1	1	1	1
CO7	**U24ME213X.7**	2	1	-	-	1	1	1	1	1	1	1	2	1
CO8	**U24ME213X.8**	2	1	-	-	1	1	1	1	1	1	1	2	1
	U24ME213X	**2**	**1**	**-**	**-**	**1**	1	**1**	**1**	**1**	1	**1**	**1.5**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

BASIC MECHANICAL ENGINEERING			
Class: B.Tech. II-Semester (Exit)		**Branch:** ME	
Course Code:	**U24ME214X**	**Credits:**	**03**
Hours/Week (L-T-P-E):	**2-0-2-4**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**32 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: the basic elements of power transmission and bearings.
LO2: the basic manufacturing processes and sand casting
LO3: principles of welding
LO4: fundamentals of machining

THEORY COMPONENT

UNIT-I	4 Hrs

Power Transmission: Classification; Flat belt drives - open and cross belts; Introduction to Gears. **Bearings**: Types - Sliding and rolling contact; Lubricants - Objectives, types, properties and applications.

UNIT-II	4 Hrs

Manufacturing Processes: Classification and their applications.
Sand Casting: Terminology; Mould cross section; Moulding sand-types and properties; Patterns-types, materials and allowances.

UNIT-III	4 Hrs

Welding: Principle, equipment and applications of gas welding, types of flames; Principle, equipment and applications of arc welding; brazing and soldering

UNIT-IV	4 Hrs

Machining: Classification; Lathe machine-line diagram and functions of various parts, lathe operations; milling machine-construction and operations, drilling machine-construction and operations

LABORATORY COMPONENT

List of Experiments

1. Prepare a Square fit using Mild Steel Plates
2. Prepare a Half round fit using Mild Steel Plates
3. Prepare a Sand Mould using bracket pattern
4. Prepare a Sand Mould using dumbbell pattern
5. Prepare a Lap joint on Mild Steel Plates using Arc Welding
6. Prepare a Single V – Butt Joint on Mild Steel Plates using Arc Welding
7. Perform a Step turning operation on mild steel bar
8. Perform a Taper turning operation on mild steel bar

Text book(s):

1. Basant Agrawal and Agrawal C.M., *Basic Mechanical Engineering*, New Delhi: Wiley India Pvt. Ltd.
2. Mathur, Mehta and Tiwari, *Elements of Mechanical Engineering*, New Delhi: Jain Brothers.
3. Hazra Chowdary. S. K and Bose, *Basic Mechanical Engineering*, Media Promoters and Publishers Pvt. Ltd, India.

Reference Book(s):

1. Nag P. K., *Engineering Thermodynamics*, New Delhi: Tata McGraw Hill.
2. Hazra Chowdary S. K and Bose, *Workshop Technology*, Vol. I & II, Media Promoters and publishers Pvt. Ltd., India,

Web and Video link(s):

https://onlinecourses.nptel.ac.in/noc24_me104/preview NPTEL Video Lecture on Basics of Mechanical Engineering – 1 Prof. Janakranjan Ramkumar, Prof. Amandeep Singh Oberoi, IIT Kanpur

Laboratory Manual (for laboratory component): *Workshop Laboratory Manual*, Department of Mechanical Engineering, KITSW.

Course Learning Outcomes (COs): Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

(based on cognitive skills acquired from theory component)

CO1: differentiate between belt drive and gear drive; Sliding and rolling contact bearings
CO2: classify manufacturing processes and illustrate sand casting process
CO3: compare and contrast arc and gas welding; brazing and soldering
CO4: draw the constructional diagram of lathe, milling, drilling and list their operations

(based on skills acquired from laboratory component)

CO5: Assemble parts of the fitting joints
CO6: design and prepare a mould cavity using single and two piece pattern
CO7: produce weld joints using arc welding and gas welding
CO8: perform various operations on lathe

Course Articulation Matrix (CAM):		**U24ME214X BASIC MECHANICAL ENGINEERING**											
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME214X.1**	1	1	-	-	-	-	1	1	1	1	1	1	1
CO2	**U24ME214X.2**	1	1	-	-	-	-	1	1	1	1	1	1	1
CO3	**U24ME214X.3**	1	1	-	-	-	-	1	1	1	1	1	1	1
CO4	**U24ME214X.4**	1	1	-	-	-	-	1	1	1	1	1	1	1
CO5	**U24ME214X.5**	1	1	-	-	-	-	1	1	1	1	1	1	1
CO6	**U24ME214X.6**	1	1	-	-	-	-	1	1	1	1	1	1	1
CO7	**U24ME214X.7**	1	1	-	-	-	-	1	1	1	1	1	1	1
CO8	**U24ME214X.8**	1	1	-	-	-	-	1	1	1	1	1	1	1
U24ME214X		**1**	**1**		-	-	-	1	1	**1**	**1**	**1**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

III SEMESTER

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	BSC	U24MH301B	Applied Mathematics	2	1	-	3	3
2	PCC	U24ME302	Mechanics of Materials	2	1	-	3	3
3	PCC	U24ME303	Manufacturing Technology	2	1	-	3	3
4	PCC	U24ME304	Heat Power Engineering	2	1	-	3	3
5	ESC	U24ME305	Python Programming	2	1	-	3	3
6	VAC	U24VA306B	Soft and Interpersonal Skills Laboratory	-	-	2	2	1
7	PCC	U24ME307	Mechanics of Materials Laboratory	-	-	2	2	1
8	PCC	U24ME308	Manufacturing Technology Laboratory	-	-	2	2	1
9	ESC	U24ME309	Python Programming Laboratory	-	-	2	2	1
Total:				**10**	**5**	**08**	**23**	**19**
Additional Learning@:Maximum credits allowed for Honours/Minor				-	-	-	-	05
Total credits for Honours/Minor students:				-	-	-	-	**25**
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)				**-**	**-**	**-**	**-**	**-**

*** Branch Specific Mathematics:**

Branch Specific Mathematics (Pool-IV)		
S. No.	**Course Code**	**Course Title**
1.	U24MH301A	Numerical and Statistical Methods ***(for Civil Engineering)***
2.	U24MH301B	Applied Mathematics ***(for Mechanical Engineering)***
3.	U24MH301C	Mathematical foundations for Signal Processing ***(for ECI)***
4.	U24MH301D	Discrete Mathematics and Probability Statistics ***(Common to CSE, CSN, CSO & IT)***
5.	U24MH301E	Essential Mathematics and Statistics for Machine learning ***(for CSM)***
6.	U24MH301F	Essential Mathematics and Statistics for Data science ***(for CSD)***

APPLIED MATHEMATICS			
Class: B. Tech. III – Semester		**Branch:** ME	
Course Code:	**U24MH301B**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : apply Laplace transforms to solve differential equations and represent a function as Fourier series

CO2 : construct analytic function, represent a complex function in series and evaluate real integrals using integral theorems

CO3 : apply numerical methods to solve simultaneous equations, differential equations, and find root of algebraic and transcendental equations

CO4 : apply theoretical probability distributions in decision making

UNIT-I	9 Hrs

Laplace Transforms-Definition**,** Conditions for the existence of Laplace transform, transforms of elementary functions, Properties of Laplace transforms- Linearity property, First shifting property, Multiplication by 't^n', Division by 't'. Inverse Transforms—Method of partial fractions, Convolution theorem (statement only), Solution to boundary value problems of ordinary differential equations

Fourier Series: Periodic functions, Orthogonal and orthonormal functions, Euler's formulae, representation of a function as trigonometric Fourier series (FS) in the intervals $(0, 2\pi)$ and $(-\pi, \pi)$, Conditions for a Fourier series expansion (Dirichlet's conditions), Half range series-half range cosine and sine series expansions in the interval $(0, \pi)$

Applications of Partial Differential Equations: Method of separation of variables- Solution of one-dimensional wave, One-dimensional heat flow, and Laplace's equations

UNIT-II	9 Hrs

Calculus of Complex functions: Functions of complex variables, Limit, Continuity, and derivative of a complex function, Analytic functions- Cauchy-Riemann equations, Harmonic functions, Application to flow problems, Construction of analytic functions-Milne-Thomson method

Complex Integration: Line integration in complex plane, Cauchy's theorem, Cauchy's integral formula, Series of complex terms-Taylor's series and Laurent's series**.** Cauchy's residue theorem and applications

UNIT-III	9 Hrs

Interpolation: Application of Lagrange interpolation to estimate the value of a dependent variable from the experimental data

Numerical Integration: Newton-Cotes quadrature formula, Trapezoidal rule, Simpson's 1/3rd rule and Simpson's 3/8th rule. Applications of Simpson's rule to find the displacement and velocity of a moving particle

Solution to System of Linear Equations: Iterative methods of solution-Jacobi's iteration method and Gauss-Seidel iteration method, Operational counts (computational complexity) for Jacobi and Gauss-Seidel iterative methods

Numerical Solution of Equations: Solution of algebraic and transcendental equations**-** Bisection method, Regula-Falsi method, Secant method and Newton Raphson method

Numerical Solution of Ordinary Differential Equations: Taylor's series method, Euler's method and Runge - Kutta method of order four

UNIT-IV	9 Hrs

Probability and Distributions: Review of the concepts of probability, Random variable, Discrete probability distribution and continuous probability distribution, Binomial distribution, Poisson distribution, Mean and variance of distributions, Normal distribution and Exponential distribution

Applications: fitting of Binomial distribution, Poisson distribution to the given real time data

Textbook(s):

1. Grewal, B.S., *Higher Engineering Mathematics*, Khanna Publishers, Delhi, 44th edition, 2017

Reference Book(S):

1. Kreyszig E, *Advanced Engineering Mathematics*, Inc, U.K, John wiely & sons, 10th edition, 2020.
2. S.P.Gupta, *Statistical Methods*, 46th ed., New Delhi: Sultan Chand & Sons, 2023.
3. S.S. Sastry, *Engineering Mathematics*, Vol.II, Prentice Hall of India, 3rd edition, 2014.
4. Richard L. Burden, Douglas Faires.J, *Numerical Analysis*,9th ed, 2011.

Web and Video link(s):

1. https://youtu.be/HoGNkZclxDU?si=K9DFQ4jVL1OQiArb : *NPTEL Video Lecture on Fourier Series and its Convergence/Dr.S.K.Gupta /IIT Roorkee*
2. https://youtu.be/2NcQi41VX9g?si=IY5I42ue87U__EDx: *NPTEL Video Lecture on Numerical methods./Prof.R. Usha / IIT Madras*

Course Articulation Matrix (CAM):		U24MH301B :APPLIED MATHEMATICS												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24MH301B.1	2	2	1	1	-	-	-	1	1	-	1	2	1
CO2	U24MH301B.2	2	2	1	1	-	-	-	1	1	-	1	2	1
CO3	U24MH301B.3	2	2	1	1	-	-	-	1	1	-	1	2	1
CO4	U24MH301B.4	2	2	1	2	-	-	-	1	1	-	1	2	1
U24MH301B		**2**	**2**	**1**	**1.25**	**-**	**-**	**-**	**1**	**1**	**-**	**1**	**2**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	apply Laplace transforms to solve differential equations and represent a function as Fourier series	SDG9	Industry, Innovation and Infrastructure	Laplace transforms are used to model and analyze Linear Time-Invariant (LTI) systems in electrical (circuit analysis), mechanical (vibration analysis), and civil engineering.
CO2	construct analytic function, represent a complex function in series and evaluate real integrals using integral theorems	SDG4	Quality Education	These topics constitute high-level engineering mathematics training, promoting "quality education" and "lifelong learning" in scientific fields.
CO3	apply numerical methods to solve simultaneous equations, differential equations, and find root of algebraic and transcendental equations	SDG9	Industry, Innovation and Infrastructure	Numerical methods are essential for structural analysis, engineering design optimization, and traffic management systems, enabling the development of robust, sustainable, and efficient urban infrastructure and industrial processes.
CO4	apply theoretical probability distributions in decision making	SDG13	Climate Action	These distributions allow decision-makers to model inherent environmental uncertainties, assess extreme risks, and optimize resource allocation under dynamic conditions. Climate change presents inherently uncertain, high-impact risks (e.g., extreme weather). Probability modeling allows governments to estimate the likelihood of disasters (e.g., flood probability, heatwave frequency) and strengthen resilience.

Mechanics of Materials			
Class: B. Tech. – III-Semester		**Branch:** MED	
Course Code:	**U24ME302**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : apply elastic constants & stress-strain relationships to solve problems involving axially loaded members & thermal stresses

CO2 : construct shear force and bending moment diagrams for beams subjected to various loads and calculate bending stresses

CO3 : determine slope and deflection of beams using analytical methods and analyze shear stress distribution across beam sections

CO4 : design circular shafts using torsion theory, evaluate thin cylindrical shells under pressure and analyze column stability using Euler's buckling theory.

UNIT-I	9 Hrs

Simple Stress and Strain: Types of loads, Stress, Shear stress, Strain, Poisson's ratio, Modulus of elasticity, Modulus of rigidity, Volumetric strain, Bulk modulus; Relation between elastic constants, Principle of superposition, Bars of varying sections, Bars of uniform strength, Compound bars, Thermal stresses, Factor of safety

UNIT-II	9 Hrs

Shear Force and Bending Moment: Types of supports and beams, Shear force, Bending moment, relation between intensity of loading, Shear force and bending moment; Shear force and bending moment diagrams for cantilever, Simply supported beams and overhanging beams

Theory of Simple Bending: Assumptions, Derivation of basic equation, Flexure formula, Modulus of section, Moment of resistance; Determination of bending stresses in beams of various cross-sections—rectangular, Solid circular, Hollow circular and I-sections

UNIT-III	9 Hrs

Deflections of Beams: Slope and deflection of cantilever and simply supported beams for point loads and uniformly distributed loads; Analysis using the double integration method and Macaulay's method

Shear Stresses in Beams: Equation of shear stress; Shear stress distribution across rectangular, Circular and I-sections

UNIT-IV	9 Hrs

Torsion of Circular Shafts: Theory of pure torsion, Derivation of basic equation, Solid and hollow circular shafts, Torsional shear stresses and angle of twist; Power transmission

Columns: Euler's crippling load of columns

Thin Cylinder: Hoop stress and longitudinal stress in thin cylinders

Textbook(s):

1. S.S. Rattan, *Strength of Materials*, 3rd ed., New Delhi: McGraw-Hill Education, 2016.

Reference Book(S):

1. B.C. Punmia, Ashok Kumar Jain, and Arun Kumar Jain, *Strength of Materials*, 10th ed., New Delhi: Laxmi Publications, 2015.
2. T.D. Gunneswara Rao and M. Andal, *Strength of Materials: Fundamentals and Applications,* 1st ed., Cambridge: Cambridge University Press, 2018.
3. Egor P. Popov, *Engineering Mechanics of Solids*, 12th ed., USA: Prentice Hall, 2016.
4. James M. Gere and Barry J. Goodno, *Mechanics of Materials*, Enhanced 9th ed., Boston MA: Cengage Learning, 2020.

5. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, and David F. Mazurek, *Mechanics of Materials*, 8th ed., New York: McGraw-Hill Education, 2019.
6. Irving H. Shames and James M. Pitarresi, *Introduction to Solid Mechanics*, 3rd ed., Upper Saddle River, NJ: Prentice Hall, 2000.
7. S. Ramamrutham and R. Narayanan, *Strength of Materials*, 18th ed., New Delhi: Dhanpat Rai Publications, 2014.

Web and Video link(s):

1. **https://nptel.ac.in/courses/112107147,** *NPTEL video lecture on Characteristics of Stress strain curve for different materials by Prof. S. K. Bhattacharyya, IIT Kharagpur.*
2. **https://nptel.ac.in/courses/105105166,** *NPTEL video lecture on Deflection of beams by Prof. B. Bhattacharjee, IIT Delhi.*

Course Articulation Matrix (CAM):		**U24ME302: Mechanics of Materials**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME302.1**	3	2	-	2	1	-	-	1	1	1	1	2	1
CO2	**U24ME302.2**	3	2	-	2	1	-	-	1	1	1	1	2	1
CO3	**U24ME302.3**	3	2	-	2	1	-	-	1	1	1	1	2	1
CO4	**U24ME302.4**	3	2	2	2	2	-	-	1	1	1	1	2	1
U24ME302		**3**	**2**	**2**	2	**1.25**	**-**	**-**	**1**	**1**	**1**	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	*apply elastic constants & stress-strain relationships to solve problems involving axially loaded members & thermal stresses*	SDG 9	Industry, Innovation and Infrastructure	Understanding stress–strain behavior and material properties helps students design safe and reliable engineering components used in industrial and infrastructure applications.
CO2	*construct shear force and bending moment diagrams for beams subjected to various loads and calculate bending stresses*	SDG 9	Industry, Innovation and Infrastructure	Analysis of beams and structural members supports the design of safe, durable, and sustainable buildings, bridges, and civil infrastructure systems.
CO3	*determine slope and deflection of beams using analytical methods and analyze shear stress distribution across beam sections*	SDG 9	Industry, Innovation and Infrastructure	Beam deflection and shear stress analysis are essential for developing efficient mechanical and structural systems with improved safety and performance.
CO4	design circular shafts using torsion theory, evaluate thin cylindrical shells under pressure and analyze column stability using Euler's buckling theory	SDG 12	Responsible Consumption and Production	Efficient design of shafts, pressure vessels, and columns promotes optimal material usage, reduces mechanical failure, and supports sustainable engineering practices.

U24ME303:MANUFACTURING TECHNOLOGY			
Class: B. Tech. III –Semester		**Branch:** Mechanical Engineering	
Course Code:	**U24ME303**	**Credits:**	**3**
Hours/Week (L-T-P-O-E):	**2-1-0-3**	**CIE Marks (%):**	**60**
Total Number of Teaching Hours:	**36 Hrs**	**ESE Marks (%):**	**40**

Course Learning Outcomes (COs):

After completion of this course, the students should be able to...

CO1: interpret various metal casting processes and design of gating/riser system for sound casting.

CO2: compare and contrast various metal forming processes; calculate loads required for rolling and drawing processes.

CO3: recommend suitable sheet metal operation for a given industrial application, design of punch, and die for punching and blanking.

CO4: classify and illustrate various welding processes.

UNIT-I	9 Hrs

Metal Casting Processes: Introduction, Pattern-materials, types and allowances; Moulding materials - sand composition, types and properties; Sand testing- Grain fineness number, moisture content, clay content and permeability; Gating system- elements of a gating system, design of gating system and riser; Casting processes-sand casting, centrifugal casting, die casting - hot and cold chamber and investment casting; casting defects**.**

UNIT-II	9 Hrs

Metal Forming Processes: Classification; cold and hot working; Rolling - principle and operation, calculation of rolling load & roll pass design; Forging - principle, operations and types - open and closed die forging, drop and upset Forging; Extrusion - principle, operation and types; Drawing - principle, operation and types - wire drawing, rod drawing and tube drawing.

UNIT-III	9 Hrs

Sheet Metal Operations: Types of sheet metals – cold rolled, close annealed and hot rolled; Shearing principle; Shearing operations-blanking, punching, lancing, nibbling, perforating, trimming, shaving, slitting and notching; Forming operations -drawing, bending, stretch forming, metal spinning, hemming, embossing and coining; Press tools: types - simple die, compound die and progressive die; Design of punch and die for punching and blanking; design of strip layout.

UNIT-IV	9 Hrs

Welding Processes: Classification; Gas welding - principle of oxy-acetylene welding, types of flames; Electric Arc welding- principle, equipment; Types-AC and DC welding; TIG and MIG welding processes; Resistance welding- principle, Types- Butt welding, Spot welding and Seam welding; Solid state welding-principle, friction welding; Thermit welding; Brazing and Soldering; Electron beam welding and laser beam welding, welding defects

Textbook(s):

1. P. N. Rao, Manufacturing Technology, 5th ed. Volume-I, New Delhi: Tata McGraw-Hill, 2018.

Reference Book(s):

1. S. K. Hajra Chowdhury, A. K. Hajra Chowdhury and Nirjhar Roy, Elements of Workshop Technology Vol-1, 17th ed. Media Promoters and Publishers Pvt. Ltd., 2015.
2. P. C. Sharma, A Textbook of Manufacturing (Technology-1), 1st ed., S. Chand publishing, 2011.
3. Amitabha Ghosh and Asok Kumar Mallik, Manufacturing Science, 2nd ed. East-West Press Pvt. Ltd., 2010.
4. V.D. Kodgire, Material Science & Metallurgy, 42nd ed. Pune: Everest Publishing House, 2018.
5. E.C. Subba Rao, Testing and Inspection of Engineering Materials, New Delhi: Tata McGraw Hill, 1998.

Web and Video link(s):
https://onlinecourses.nptel.ac.in/noc24_me123/preview; *NPTEL Video Lecture on Fundamentals of Manufacturing Processes By Prof. D K Dwivedi, Professor of ME, IIT Roorkee.*

Course Articulation Matrix (CAM): U24ME303: MANUFACTURING TECHNOLOGY													
CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO1	PSO 2
CO1	U24ME303.1	2	2	1	-	-	1	-	-	1	-	1	2	1
CO2	U24ME303.2	2	2	1	-	-	1	-	-	1	-	1	2	1
CO3	U24ME303.3	2	2	1	-	-	1	-	-	1	-	1	2	1
CO4	U24ME303.4	2	2	1	-	-	1	-	-	1	-	1	2	1
U24ME303		**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**	**1**	**1**	2	1

CO	CO Statement – The student should be able to…	Relevant SDG	SDG Description	Mapping Justification
CO1	Interpret various metal casting processes and design of gating/riser system for sound casting	SDG 9	Industry, Innovation and Infrastructure	Efficient casting design improves manufacturing quality, minimizes defects, reduces material wastage, and supports sustainable industrial production systems.
CO2	Compare and contrast various metal forming processes; calculate loads required for rolling and drawing processes	SDG 12	Responsible Consumption and Production	Understanding forming processes and load calculations promotes optimized material usage, energy efficiency, and reduction of manufacturing waste.
CO3	Recommend suitable sheet metal operation for a given industrial application and design of punch and die for punching and blanking	SDG 9	Industry, Innovation and Infrastructure	Tool and process design for sheet metal operations enhances precision manufacturing, industrial productivity, and technological innovation.
CO4	Classify and illustrate various welding processes	SDG 8	Decent Work and Economic Growth	Knowledge of welding processes develops technical skills essential for manufacturing industries, improving employability and supporting economic growth.

HEAT POWER ENGINEERING			
Class: B. Tech. III – Semester		**Branch:** ME	
Course Code:	**U24ME304**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: compute the properties of steam, efficiency of Rankine cycle with reheat and regeneration, and categorize the boiler

CO2: evaluate the performance of steam turbines

CO3: analyse IC engines working and their performance parameters

CO4: explain the advancements in IC engines and the working principle of electric vehicles

UNIT-I	**9 Hrs**

Properties of Steam: Steam properties, use of (Steam) property tables, Mollier diagram

Vapor Power Cycles: Components of the Steam Power Cycle, Rankine Cycle, P-V, h-s and T-s diagrams, Rankine cycle with superheat, reheat, and regeneration

Steam Generators: Classification of boilers, Criteria for selection of a boiler, functions of Boiler Mountings and Accessories

UNIT-II	**9 Hrs**

Steam Turbines: Classification, Compounding of Impulse and Reaction Turbines

Impulse turbine: Velocity diagrams, power output, axial thrust, maximum blade efficiency of a single stage, impulse turbine

Reaction turbine: Velocity diagrams, degree of reaction, power output, maximum blade efficiency, Comparison of impulse and impulse-reaction turbines

UNIT-III	**9 Hrs**

Introduction: Basic engine components and nomenclature; classification of engines; Working principle of two and four stroke SI & CI engines; valve and port timing diagrams

Testing of IC Engines: Measurement of brake power, friction power and indicated power; indicator diagram, fuel and air consumption; performance parameters–mean effective pressure, specific fuel consumption, air-fuel ratio, mechanical, volumetric and thermal efficiencies; heat balance sheet; effect of clearance volume on volumetric efficiency

UNIT-IV	**9 Hrs**

Advances in IC engines: Effect of supercharging on thermal efficiency; methods of supercharging and scavenging, Working principles of EGR, MPFI, CRDI and HCCI

Electric Vehicles: Introduction: History of EVs, EV system, basic structure- Electric vehicle drive train-advantages and limitations, Components of EV Battery run EVs and Electric Motor run EVs-Brief treatment on types of electric machines for EVs (Power-Torque characteristics), regenerative braking system.

Textbook(s):

1. Mahesh M. Rathore, "*Thermal Engineering*", Tata McGraw-Hill publications, 1st edn., 2010, New Delhi.
2. Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao, Stefano Longo, and Kambiz Ebrahimi, CRC Press, 2018 II Edition.

Reference Book(s):

1. Electric vehicle technology explained, John Lowry and James Larmine, John Wiley and Sons, 2012.
2. V. P. Vasandani and D. S. Kumar, "Heat Engineering", *Metropolitan Book Co Pvt. Ltd*., 4rd edn., 2008.

Data Book(s):

1. C. P. Kothandaraman, P B Nagaraj and D Venkatesh, *Refrigerant Tables and Charts including Air Conditioning Data*, New Age International Publishers, New Delhi, 2006.
2. Mathur, M. L., and Mehta, F. S., *Refrigerant and Psychrometric Properties (Tables & Charts) SI Units*, Jain Brothers Publishers, New Delhi, 2010.
3. Khurmi, R. S., and Gupta, J. K., *Refrigeration Tables with chart*, S. Chand Publishers, New Delhi, 2008.

Web and Video link(s):

1. https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8; N*PTEL Video Lecture on Basic Thermodynamics by Prof. S. K. Som, Professor of Mechanical Engineering, IIT Kharagpur.*
2. https://nptel.ac.in/courses/112102255; *NPTEL Video Lecture on Thermodynamics by Prof. S. R. Kale, Professor of Mechanical Engineering, IIT Delhi.*

Course Articulation Matrix (CAM):		**U24ME304 HEAT POWER ENGINEERING**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME304.1**	3	3	2	2	-	1	-	-	-	1	1	2	1
CO2	**U24ME304.2**	3	3	2	2	-	1	-	-	-	1	2	2	1
CO3	**U24ME304.3**	3	3	2	2	-	1	-	-	-	1	3	2	1
CO4	**U24ME304.4**	3	3	2	2	-	1	-	-	-	1	2	2	1
U24ME304		3	3	2	2	-	1	-	-	-	1	2	2	1

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	compute the properties of steam, efficiency of Rankine cycle with reheat and regeneration, and categorize the boiler	**SDG7**	Affordable and Clean Energy	Enhances understanding of efficient thermal power generation systems and energy conversion technologies for sustainable energy utilization.
CO2	evaluate the performance of steam turbines	**SDG9**	Industry, Innovation and Infrastructure	Supports efficient turbine operation and industrial power system optimization through performance analysis.
CO3	analyse IC engines working and their performance parameters	**SDG12**	Responsible Consumption and Production	Encourages fuel-efficient engine operation and reduced energy wastage through performance evaluation.
CO4	explain the advancements in IC engines and the working principle of electric vehicles	**SDG13**	Climate Action	Promotes cleaner transportation technologies and reduced environmental impact through advanced engines and electric vehicles.

PYTHON PROGRAMMING			
Class: B. Tech. III – Semester		**Branch:** ME	
Course Code:	**U24ME305**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: develop python programs using control statements, operators and functions

CO2: apply collections, namespaces, packages, strings and regular expressions in application development

CO3: apply object-oriented programming principles in real-time problem solving

CO4: develop visualization graphs with Matplotlib and apply Numpy and Pandas libraries for data analysis

UNIT-I	9 Hrs

Introduction: Features of Python; The future of Python; Writing and executing Python programs, Testing and Debugging

Python Preliminaries: Literal constants; Variables and identifiers; Data types; Input operation; Comments; Reserved words; Indentation; Operators - Operator Precedence and Associativity; Expressions in Python; Type conversion;

Decision Control Statements: Selection/Conditional branching statements; Loop structures/ iterative statements; Nested loop; The continue statement; The pass statement; The else statement used with loops

Functions: Function definition; Function call; Variable scope and lifetime; The return statement; Advances in defining in functions; Recursive functions; Lambda functions; Document Strings; Iterators; Decorators; Generators

UNIT-II	9 Hrs

Modules and Name Spaces: The from…import statement; Naming module; The dir() function; Packages in Python; Standard library modules; Globals(), Locals(), and Reload(); Function redefinition

Python Strings: String operations; String formatting operator; Built-in string methods and functions; Slice operation; ord() and chr() functions; in and not in operators; Comparing strings; Regular expressions; Meta characters

Data Structures: Lists; Tuple -Variable-length Argument Tuples; The zip() Function; Sets; Dictionaries; Comprehension; High order functions**;** String formatting with Dictionaries

UNIT-III	9 Hrs

Python Object Oriented Programming: Classes and Objects; Class method and Self-argument; The __init__() method; Class variables and Object variables; The __del__() method; Public and Private data members; Private methods; Calling class method from another class method; Built in class variables; Garbage Collection; Class methods; Static methods; Inheritance; Complex objects; Meta classes, Polymorphism; Operator overloading; Magic Methods

Error and Exception Handling: Introduction to errors and exceptions; Handling exceptions; Multiple except blocks; Multiple Exceptions in a Single Block; Raising exception; Instantiating exceptions; Handling exceptions in Invoked Function; Built-in and User-defined exceptions; The finally Block, Re-raising exceptions; Assertions; Multi-threading

File Handling: Opening and closing files; Reading and writing files; File positions; Renaming and deleting files; Directory methods

Database Connectivity: SQLite-creating a database table, Insert and retrieve data from database

UNIT-IV	9 Hrs

NumPy: The basics of NumPy arrays; Array indexing; Array slicing; Reshaping of array; Concatenation and splitting arrays; Aggregations; Universal Functions; Broad casting of Arrays; Sorting array; Structured array operations

Data Manipulation with Pandas: Installing and using Pandas; Introducing Pandas objects; Data

indexing and selection; Handling missing data; Combining datasets; Merge and join, Aggregation and grouping; Multi-Indices; Pivoting table; Vectorized String Operations, Working with Time Series

Visualization with Matplotlib: Importing Matplotlib; Saving figures to files; Simple line plots; Simple scatter plots; Visualizing errors; Density and Contour plots; Histograms; Binnings, and Density; Customizing color bars; Three-Dimensional Plotting in Matplotlib; Geographic Data with Basemap

Textbook(s):

1. Reema Thareja, *Python Programming using problem solving approach*, 1st ed. New Delhi: Oxford University Press, 2017 *(Chapter 1 to 7)*
2. Jake VanderPlas, *Python Data Science Handbook- Essential Tools for Working with Data*, 1st ed. California: O'Reilly Media, 2016 (*Chapter 2 to 4*)

Reference Book(s):

1. Dr. Charles R. Severance, *Python for Everybody-Exploring Data Using Python*, 1st ed. New Delhi: Shroff Publishers, 2016.
2. David Beazley, *Python Cookbook*, 3rd ed. California: O'Reilly Media, Inc., 2013.
3. Caleb Hattingh, *20 Python Libraries You Aren't Using*, 2nd ed. California: O'Reilly Media, 2016.
4. Magnus Lie Hetland, *Beginning Python: from Novice to Professional*, 1st ed. New York: Apress, 2005.

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc23_cs99/ *NPTEL Video Lecture on Python For Data Science by Prof. Ragunathan Rengasamy, IIT Madras.*
2. https://onlinecourses.nptel.ac.in/noc25_cs17 *NPTEL Video Lecture on Data Analytics with Python by Prof. A Ramesh, IIT Roorkee.*
3. https://onlinecourses.nptel.ac.in/noc25_cs69/ *NPTEL Video Lecture on The Joy of Computing using Python By Prof. Sudarshan Iyenga, IIT Ropar*

Course Articulation Matrix (CAM):		**U24ME305 PYTHON PROGRAMMING**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME305.1**	2	2	2	2	2	1	-	-	-	1	1	1	1
CO2	**U24ME305.2**	2	2	2	2	2	1	-	-	-	1	1	1	1
CO3	**U24ME305.3**	2	2	2	2	2	1	-	-	-	1	1	1	1
CO4	**U24ME305.4**	2	2	2	2	2	1	-	-	-	1	1	1	1
U24ME305		**2**	**2**	**2**	**2**	**2**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	develop python programs using control statements, operators and functions	**SDG4**	Quality Education	Enhances programming and computational skills required for modern technical education and lifelong learning.
CO2	apply collections, namespaces, packages, strings and regular expressions in application development	**SDG9**	Industry, Innovation and Infrastructure	Supports software application development and innovation through efficient programming practices.
CO3	apply object-oriented programming principles in real-time problem solving	**SDG8**	Decent Work and Economic Growth	Develops industry-relevant software design and problem-solving skills that improve employability and productivity.
CO4	develop visualization graphs with Matplotlib and apply Numpy and Pandas libraries for data analysis	**SDG9**	Industry, Innovation and Infrastructure	Promotes data-driven analysis, technological innovation, and intelligent decision-making in engineering applications.

SOFT AND INTERPERSONAL SKILLS LABORATORY

Class: B. Tech. III Semesters		**Branch:** Common to all Branches	
Course Code:	**U24VA306B**	**Credits:**	**1**
Hours/Week (L-T-P-O-E):	**0-0-2-2**	**CIE:**	**100 %**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**-**

Course Learning Outcomes (COs):

After completion of this course, the students should be able to…

CO1: deliver concise & effective self-introduction and demonstrate confidence, spontaneous speaking skills within a limited time

CO2: conduct a personal SWOT analysis to identify areas for self-improvement and career development

CO3: demonstrate clear & respectful communication, leadership, positive attitude and improve interpersonal relationship by actively participating in group discussions, collaborative tasks & mock interviews

CO4: create a professional resume, develop a LinkedIn profile and demonstrate effective video communication by making effective videos on self-introduction, personal SWOT analysis & spontaneous speaking activity along with email & workplace etiquette

LIST OF ACTIVITIES

Activity 1: Ice-breaking, Self-Awareness and Just a Minute (JAM)
Activity 2: Self-Introduction & Personal SWOT Analysis
Activity 3: Reading Comprehension & Critical Thinking
Activity 4: Active Listening & Non-Verbal Observation (Video + Peer Practice)
Activity 5: Group Discussion - 1
Activity 6: Resume Building & LinkedIn Profile Review
Activity 7: Group Discussion - 2
Activity 8: Presentation Skills with PPT / Storytelling
Activity 9: Group Discussion - 3
Activity 10: Mock Interviews: Technical & HR
Activity 11: Email Etiquette & Professional Communication
Activity 12: Workplace Etiquette & Conflict Resolution

Textbook(s):

1. Krishna Mohan & Meera Benerji, *Developing Communications Skills*, 2nd ed., New Delhi: McMillan Publications, 2005

Course Articulation Matrix (CAM):		**U24VA306B SOFT AND INTERPERSONAL SKILLS LABORATORY**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24VA306B.1**	-	-	-	-	-	-	-	2	3	-	1		
CO2	**U24VA306B.2**	-	-	-	-	-	-	2	3	3	-	1		
CO3	**U24VA306B.3**	-	-	-	-	-	-	-	2	3	-	1		
CO4	**U24VA306B.4**	-	-	-	-	-	-	1	2	3	-	1		
U24VA306B		-	-	-	-	-	-	**1.5**	**2.25**	**3**	-	**1**		
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG ALIGNMENT MATRIX				
CO	**CO Statement** **The student should be able to**	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	deliver concise & effective self-introduction and demonstrate confidence, spontaneous speaking skills within a limited time	SDG 4	Quality Education	This aligns with SDG-4 as it focuses on developing communication skills, confidence and spontaneous speaking ability along with delivering a concise and effective self-introduction in a time-bound manner, which are essential for effective learning and employability
CO2	conduct a personal SWOT analysis to identify areas for self-improvement and career development	SDG 4	Quality Education	This aligns with SDG-4 as it encourages self-awareness and lifelong learning through personal SWOT analysis, enabling learners to identify strengths, weaknesses, opportunities, and threats for self-improvement and career development
CO3	demonstrate clear & respectful communication, leadership, positive attitude and improve interpersonal relationship by actively participating in group discussions, collaborative tasks & mock interviews	SDG 4	Quality Education	This aligns with SDG-4 as it develops communication, leadership, teamwork and interpersonal skills through active participation in group discussions, collaborative tasks and mock interviews, enhancing learners' overall competence and employability
CO4	create a professional resume, develop a LinkedIn profile and demonstrate effective video communication by making effective videos on self-introduction, personal SWOT analysis & spontaneous speaking activity along with email & workplace etiquette	SDG 4	Quality Education	This aligns with SDG-4 as it enhances learners' professional, digital and communication competencies through the creation of a resume, development of a LinkedIn profile, effective video-based communication and practice of email and workplace etiquette, thereby strengthening employability and career readiness

MECHANICS OF MATERIALS LABORATORY			
Class: B. Tech. III– Semester		**Branch:** ME	
Course Code:	**U24ME307**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
		ESE:	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : plot and interpret stress–strain characteristics of mild steel / TOR steel

CO2 : determine the hardness of materials using standard hardness tests

CO3 : estimate stiffness and modulus of rigidity through compression tests on springs and torsion tests on shafts

CO4 : examine the mechanical behavior and limitations of materials through experimental testing.

LIST OF EXPERIMENTS

1. Determination of stress–strain characteristics of mild steel / TOR steel
2. Determination of the compressive strength of wood
3. Determination of Brinell's hardness numbers for steel, brass, and aluminum
4. Determination of the modulus of rigidity by conducting a torsion test on a solid shaft/hollow shaft
5. Determination of the modulus of rigidity by conducting a compression test on a spring
6. Determination of the Young's modulus of the given material by conducting a flexural test on a simply supported beam
7. Determination of the Young's modulus of the given material by conducting a flexural test on a continuous beam
8. Determination of the Young's modulus of the given material by conducting a flexural test on a propped cantilever beam
9. Bend and rebend test on a steel specimen
10. Shear test for a mild steel specimen
11. Impact test on metal specimens using the Izod test
12. Impact test on metal specimens using the Charpy test

Laboratory Manual :

Mechanics of Materials Laboratory Manual, Dept. of ME, KITSW.

Reference Book(S):

1. S.S. Rattan, *Strength of Materials*, 3rd ed., New Delhi: McGraw-Hill Education, 2016.B.C. Punmia, Ashok Kumar Jain, and Arun Kumar Jain, *Strength of Materials*, 10th ed., New Delhi: Laxmi Publications, 2015.
2. T.D. Gunneswara Rao and M. Andal, *Strength of Materials: Fundamentals and Applications,* 1st ed., Cambridge: Cambridge University Press, 2018.
3. Egor P. Popov, *Engineering Mechanics of Solids*, 12th ed., USA: Prentice Hall, 2016.
4. James M. Gere and Barry J. Goodno, *Mechanics of Materials*, Enhanced 9th ed., Boston MA: Cengage Learning, 2020.
5. Ferdinand P. Beer, E. Russell Johnston Jr., John T. DeWolf, and David F. Mazurek, *Mechanics of Materials*, 8th ed., New York: McGraw-Hill Education, 2019.
6. Irving H. Shames and James M. Pitarresi, *Introduction to Solid Mechanics*, 3rd ed., Upper Saddle River, NJ: Prentice Hall, 2000.
7. S. Ramamrutham and R. Narayanan, *Strength of Materials*, 18th ed., New Delhi: Dhanpat Rai Publications, 2014.
8. E.C. Subba Rao, *Testing and Inspection of Engineering Materials*. 1st ed., New Delhi: Tata McGraw-Hill, 1998.
9. Harmer E. Davis, George Earl Troxell, and Clement T. Wiskocil, *The Testing and Inspection of Engineering Materials*, 2nd ed., New York: McGraw-Hill Book Company, 1955.
10. A.V.K. Suryanarayana, *Testing of Metallic Materials*, 2nd ed., Hyderabad: BS Publications, 2018.

Web and Video link(s):

1. **https://nptel.ac.in/courses/112107147,** *NPTEL video lecture on Characteristics of Stress strain curve for different materials by Prof. S. K. Bhattacharyya, IIT Kharagpur.*
2. **https://nptel.ac.in/courses/105105166,** *NPTEL video lecture on Deflection of beams by Prof. B. Bhattacharjee, IIT Delhi.*

Course Articulation Matrix (CAM):		**U24ME307: MECHANICS OF MATERIALS LABORATORY**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME307.1**	3	2	-	2	2	-	-	1	1	1	1	2	1
CO2	**U24ME307.2**	3	-	-	2	2	-	-	1	1	1	1	2	1
CO3	**U24ME307.3**	3	2	-	2	2	-	-	1	1	1	1	2	1
CO4	**U24ME307.4**	3	2	2	2	2	1	1	1	1	1	1	2	1
U24ME307		2	2	2	2	2	1	1	1	1	1	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	plot and interpret the stress–strain characteristics of mild steel / TOR steel	SDG 9	Industry, Innovation and Infrastructure	Understanding stress–strain behavior of engineering materials helps in selecting suitable materials for safe, reliable, and sustainable industrial and structural applications.
CO2	determine the hardness of materials using standard hardness tests	SDG 12	Responsible Consumption and Production	Hardness testing supports quality assessment and proper material selection, leading to efficient utilization of resources and reduced material wastage.
CO3	estimate stiffness and modulus of rigidity through compression tests on springs and torsion tests on shafts	SDG 9	Industry, Innovation and Infrastructure	Experimental evaluation of stiffness and rigidity contributes to the design and development of efficient mechanical systems and industrial components.
CO4	examine the mechanical behavior and limitations of materials through experimental testing.	SDG 4	Quality Education	Experimental learning enhances practical knowledge, engineering skills, and scientific understanding, supporting outcome-based technical education and lifelong learning.

MANUFACTURING TECHNOLOGY LABORATORY			
Class: B. Tech. III – Semester		**Branch:** ME	
Course Code:	**U24ME308**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1:	prepare specimen for metallography and observe microstructure of ferrous metals.
CO2:	conduct destructive and non-destructive testing on a given specimen.
CO3:	prepare the sand specimen and conduct standard tests to measure properties of moulding sand; design a given wooden pattern.
CO4:	prepare a given joint using various welding processes; perform shallow cup drawing operation.

LIST OF EXPERIMENTS

1. Observation of microstructures of low, medium and high carbon steels.
2. Observation of microstructure of cast irons – grey, nodular and white cast irons.
3. Measurement of hardness of ferrous and non-ferrous metals.
4. Conduction of liquid penetration test for weld joints.
5. Preparation of the specimen using powder metallurgy process.
6. Determination of Grain Fineness Number (GFN) of a given sample sand and Shatter Index (SI) of a moulding sand.
7. Determination of moisture and clay contents of a given moulding sand.
8. Design and development of a wooden pattern for aluminium casting.
9. Preparation of a pipe joint using oxy-acetylene welding.
10. Preparation of a lap joint using resistance spot welding and TIG welding
11. Conduction of a bend test on a single V butt joint prepared by DC Arc welding.
12. Drawing of a shallow cup using hydraulic press.

Textbook(s):

1. P. N. Rao, Manufacturing Technology, 5th ed. Volume-I, New Delhi: Tata McGraw-Hill, 2018.

Reference Book(S):

1. S. K. Hajra Chowdhury, A. K. Hajra Chowdhury and Nirjhar Roy, Elements of Workshop Technology Vol-1, 17th ed. Media Promoters and Publishers Pvt. Ltd., 2015.
2. P. C. Sharma, A Textbook of Manufacturing (Technology-1), 1st ed., S. Chand publishing, 2011.
3. Amitabha Ghosh and Asok Kumar Mallik, Manufacturing Science, 2nd ed. East-West Press Pvt. Ltd., 2010.
4. V.D. Kodgire, Material Science & Metallurgy, 42nd ed. Pune: Everest Publishing House, 2018.
5. E.C. Subba Rao, Testing and Inspection of Engineering Materials, New Delhi: Tata McGraw Hill, 1998.

Laboratory Manual (for laboratory component):

2. *Material Science & Manufacturing Processes Laboratory Manual & Record Book,* Department of ME, KITSW.

Course Articulation Matrix (CAM): U24ME308: MANUFACTURING TECHNOLOGY LAB														
CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PS O1	PSO 2
CO1	U24ME308.1	3	2	-	-	1	1	-	2	1	-	1	2	1
CO2	U24ME308.2	3	2	-	-	1	1	-	2	1	-	1	2	1
CO3	U24ME308.3	3	2	-	-	1	1	-	2	1	-	1	2	1
CO4	U24ME308.4	3	2	-	-	1	1	-	2	1	-	1	2	1
U24ME308		**3**	**2**	**-**	**-**	**1**	**1**	-	**2**	**1**	-	**1**	**2**	**1**

CO	CO Statement – The student should be able to	Relevant SDG	SDG Description	Mapping Justification
CO1	Prepare specimen for metallography and observe microstructure of ferrous metals	SDG 9	Industry, Innovation and Infrastructure	Metallography helps in understanding material behavior and improving the quality, reliability, and performance of engineering materials used in industries and infrastructure development.
CO2	Conduct destructive and non-destructive testing on a given specimen	SDG 12	Responsible Consumption and Production	Material testing ensures product quality, safety, and efficient utilization of materials while reducing failures, wastage, and unnecessary resource consumption.
CO3	Prepare the sand specimen and conduct standard tests to measure properties of moulding sand; design a given wooden pattern	SDG 9	Industry, Innovation and Infrastructure	Foundry testing and pattern design support sustainable manufacturing practices, process optimization, and development of efficient industrial production systems.

PYTHON PROGRAMMING LABORATORY			
Class: B. Tech. III – Semester		**Branch:** ME	
Course Code:	**U24ME309**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: implement and test python programs using operators, control statements and functions

CO2: implement and test python packages using string handling methods, regular expressions, and collections

CO3: implement and test object-oriented paradigms and database operations in Python programming

CO4: build visualization graphs with Matplotlib and adapt packages like Numpy, Pandas for data analysis

LIST OF EXPERIMENTS

Experiment-1

1. Installation of Python and verifying PATH environment variable
2. Running instructions in Interactive interpreter and a python script
   a. Executing instructions in Python Interactive Interpreter
   b. Running python scripts in Command Prompt
   c. Running python scripts in IDLE
3. Develop a Python program to demonstrate importance of indentations. Purposefully raise indentation error and correct it
4. Develop a Python program to take input text as command line argument and display it on screen

Experiment-2

1. Develop a Python program that takes 2 numbers as command line arguments and print its sum
2. Develop a Python program to check whether the given number is even or odd
3. Develop a Python program to calculate GCD of 2 numbers
4. Develop a Python program to find Exponentiation (Power) of a number
5. Develop a Python program to find given year is leap year or not
6. Develop a Python program to develop a simple calculator

Experiment-3

1. Develop a Python program to find the Factorial of a given number
2. Develop a Python program to find the Armstrong for a given number
3. Develop a Python program to take a number as input, and print countdown from that number to zero (use while loop)
4. Develop a Python program to demonstrate Iterators
5. Develop a Python program to demonstrate Decorators
6. Develop a Python program to demonstrate Generators

Experiment-4

1. Develop a Python program to implement a module using import statement (Use python source file as a Module and implement import statement another python source files)
2. Develop a Python program to implement from, import statement
3. Develop a Python program to implement dir() function
4. Develop a Python program to demonstrate packages in python

Experiment-5

1. Develop a Python program on strings for the following:
   a. To display substring in a string
   b. To update an existing string
   c. To implement string concatenation
   d. To demonstrate string formatting operator

2. Develop a Python program to demonstrate use of slicing in strings
3. Develop a Python program to compare two strings
4. Reverse string and call this function for performing the operation)
5. Develop a Python program to demonstrate regular expression functions
6. Develop a Python program to demonstrate regular expressions using Meta characters

Experiment-6

1. Develop a Python program to demonstrate list and related functions
2. Develop a Python program to demonstrate tuple and related functions
3. Develop a Python program to demonstrate set and related functions
4. Develop a Python program to demonstrate dictionaries
5. Develop a Python program to demonstrate comprehensions
6. Develop a Python program to demonstrate high order functions

Experiment-7

1. Develop a Python program to demonstrate classes and objects
2. Develop a Python program to demonstrate class method
3. Develop a Python program to demonstrate static method
4. Develop a Python program to demonstrate inheritance
5. Develop a Python program to demonstrate polymorphism
6. Develop a Python program to demonstrate magic methods.

Experiment-8

1. Develop a Python program to demonstrate multiple exception handling
2. Develop a Python program to demonstrate multiple exception rising
3. Develop a Python program to demonstrate multiple finally block
4. Develop a Python program to demonstrate Assertions
5. Develop a Python program on file operations for the following
   a. To open and read data from a file
   b. To write data into a file
   c. To compute number of characters, words, lines in a file

Experiment-9

1. Develop a Python programs to implement database connectivity
   a. Install and verify SQLite Connector for Python
   b. To connect check SQLite Database connectivity
   c. To retrieve and display data from a table
   d. To insert data into a table
   e. To delete rows in a table

Experiment-10

1. Develop a Python program to demonstrate NumPy array
2. Develop a Python program to demonstrate Slice operation
3. Develop a Python program to demonstrate Reshaping of an array
4. Develop a Python program to demonstrate U-functions
5. Develop a Python program to demonstrate Broadcasting of NumPy arrays
6. Develop a Python program to demonstrate Aggregate operations

Experiment-11

1. Develop a Python Pandas program to create a series from a ndarray
2. Develop a Python Pandas program to create a series from input files
3. Develop a Python Pandas program to demonstrate indexing and slicing data frames
4. Develop a Python Pandas program to demonstrate handling missing values
5. Develop a Python Pandas program to demonstrate vectorized string operations,
6. Develop a Python Pandas program to demonstrate handling time series data

Experiment-12

1. Develop a Python program to draw a simple line plot
2. Develop a Python program to draw a scatter plots
3. Develop a Python program to draw a histogram plot
4. Develop a Python program to draw a binning and density

5. Develop a Python program to demonstrate a three-dimensional plotting
6. Develop a Python program to demonstrate a geographic basemap

Textbook(s):

1. Reema Thareja, *Python Programming using problem solving approach*, 1st ed. New Delhi: Oxford University Press, 2017 (Chapter 1 to 7)
2. Jake VanderPlas, *Python Data Science Handbook- Essential Tools for Working with Data*, 1st ed. California: O'Reilly Media, 2016 (*Chapter 2 to 4*)

Reference Book(s):

1. Dr. Charles R. Severance, *Python for Everybody-Exploring Data Using Python*, 1st ed. New Delhi: Shroff Publishers, 2016.
2. David Beazley, *Python Cookbook*, 3rd ed. California: O'Reilly Media, Inc., 2013.
3. Caleb Hattingh, *20 Python Libraries You Aren't Using*, 2nd ed. California: O'Reilly Media, 2016.
4. Magnus Lie Hetland, *Beginning Python: from Novice to Professional*, 1st ed. New York: Apress, 2005.

Laboratory Manual:

1. *Python Programming Laboratory Manual,* Department of ME, KITSW

Course Articulation Matrix (CAM):		**U24ME309: PYTHON PROGRAMMING LABORATORY**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME309.1**	2	2	2	2	2	1	1	1	1	1	2	1	1
CO2	**U24 ME310.2**	2	2	2	2	2	1	1	1	1	1	2	1	1
CO3	**U24 ME310.3**	2	2	2	2	2	1	1	1	1	1	2	1	1
CO4	**U24 ME310.4**	2	2	2	2	2	1	1	1	1	1	2	1	1
U24ME309		**2**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	implement and test python programs using operators, control statements and functions	SDG4	Quality Education	Develops computational thinking and programming skills essential for quality technical education and lifelong learning.
CO2	implement and test python packages using string handling methods, regular expressions, and collections	SDG9	Industry, Innovation and Infrastructure	Encourages software development skills and innovative programming practices for modern industrial applications.
CO3	implement and test object-oriented paradigms and database operations in Python programming	SDG8	Decent Work and Economic Growth	Enhances industry-oriented software and database management skills that improve employability and productivity.
CO4	build visualization graphs with Matplotlib and adapt packages like Numpy, Pandas for data analysis	SDG9	Industry, Innovation and Infrastructure	Supports data analytics, visualization, and technology-driven decision-making in engineering and industrial systems.

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	PCC	U24ME401	Heat Transfer	2	1	-	3	3
2	PCC	U24ME402	Machine Drawing	3	-	2	5	4
3	PCC	U24ME403	Fluid Mechanics and Hydraulic Machines	2	1	-	3	3
4	PCC	U24ME404	Design of Machine Elements	2	1	-	3	3
5	PCC	U24ME405	Machine Tools and Metrology	2	1	-	3	3
6	SEC	U24SE406	Programming Skill Development Laboratory	-	-	2	2	1
7	PCC	U24ME407	Modelling Laboratory	-	-	2	2	1
8	PCC	U24ME408	Fluid Mechanics and Hydraulic Machines Laboratory	-	-	2	2	1
9	PCC	U24ME409	Machine Tools and Metrology Laboratory	-	-	2	2	1
10	VAC*	U24CY411*	Environmental Studies*	2*	-	-	2*	1*
Total:				**11**	**4**	**10**	**25**	**20**
Additional Learning@: Maximum credits allowed for Honours/Minor				-	-	-	-	05
Total credits for Honours/Minor students:				-	-	-	-	25
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)				**-**	**-**	**-**	**-**	**-**

For Lateral Entry Students Only

Bridge Courses for exit:

Successful completion of two subjects (6-Credits) during 2-months internship at the institute

OR

Successful completion of two suitable skill based courses (external) to qualify for Certification

B. After Second Year: (UG Diploma in ME)

(i) The candidate should pass any two of the following additional courses (Diploma Level) during the 2-Months internship at institute

Exit Option to Qualify UG Diploma in ME: Any Two (02) Courses during the 2 - Months internship								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	PCC	U24ME412X	Theory of Machines	**2**	**-**	**2**	**4**	**3**
2	PCC	U24ME413X	Workshop Technology	**2**	**-**	**2**	**4**	**3**
3	PCC	U24ME414X	Refrigeration Systems	**2**	**-**	**2**	**4**	**3**
4	PCC	U24ME415X	Any other course approved by BoS Chair and Dean AA	**2**	**-**	**2**	**4**	**3**

(OR)

(ii) Any two suitable skill based courses to qualify for Diploma.

Exit Option to Qualify UG Diploma in ME: Any Two (02) Skill based Courses -:								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	SEC	U24SE412X	Certificate Course in Product Design and Analysis (Offered by MSME-CITD)	**-**	**-**	**6**	**6**	**3**
2	SEC	U24SE413X	Certificate Course in Design Of Plastic Injection Moulds (CITD)	**-**	**-**	**6**	**6**	**3**
3	SEC	U24SE414X	Certificate Course in Design of Press Tools (CITD)	**-**	**-**	**6**	**6**	**3**
4	SEC	U24SE415X	Mechanic Motor Vehicle (NSQF)	**-**	**-**	**6**	**6**	**3**
5	SEC	U24SE416X	Any other skill based course approved by BoS Chair and Dean AA	**-**	**-**	**6**	**6**	**3**

B. Tech Honours with Research:

Students opting for B. Tech Honours with Research, shall undergo a 2-Month Mandatory Research Internship-I (5 Credits) at respective department during the summer vacation after IV Semester.

HEAT TRANSFER			
Class: B. Tech. IV – Semester		**Branch:** ME	
Course Code:	**U24ME401**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: evaluate critical radius of insulation & heat transfer through composite walls and fins

CO2 : analyze transient heat conduction and forced convection heat transfer for various flows

CO3: solve free convection, boiling, condensation and design of heat exchangers problems

CO4: estimate radiation heat transfer between black and gray bodies

UNIT-I	9 Hrs

Basic modes of heat transfer: Fourier's law of heat conduction, Newton's law of cooling, Stefan-Boltzmann's law of thermal radiation; Thermal conductivity and thermal resistance

Conduction: General heat conduction equation in cartesian and cylindrical coordinate systems; Thermal diffusivity; Boundary and initial conditions; One-dimensional steady state heat conduction without heat generation in plane walls, cylinders and spheres; composite systems; critical thickness of insulation; one-dimensional steady state heat conduction with internal heat generation in plane walls

Extended Surfaces: Types and applications; one-dimensional heat conduction equation for uniform cross-sectional area - infinitely long fin, fin of finite length with insulated tip and tip with convective conditions; efficiency and effectiveness

UNIT-II	9 Hrs

Transient Heat Conduction: Lumped body analysis; governing equation for lumped system; Significance of Biot and Fourier number; Time constant

Convection: Mechanisms of free and forced convective heat transfer; physical significance of dimensionless parameters - Reynolds, Prandtl, Nusselt, Stanton, Peclet, Grashof and Rayleigh's number; dimensional analysis - Buckingham's π theorem for forced convection

Forced Convection: External flow & internal flow - hydrodynamic and thermal boundary layer theory; use of empirical correlations for convective heat transfer - flat plate, cylinders and horizontal pipe

UNIT-III	9 Hrs

Free Convection: Dimensional analysis - Buckingham's π theorem for free convection, development of hydrodynamic and thermal boundary layers along a vertical plate; Use of empirical correlations for convective heat transfer – vertical plate

Boiling and Condensation: Heat transfer accompanied by phase change; regimes of pool boiling and flow boiling; film and drop wise condensation

Heat Exchangers: Classification - parallel flow, counter flow, multi-pass and cross flow heat exchangers, condensers and evaporators; Logarithmic mean temperature difference; NTU-effectiveness method.

UNIT-IV	9 Hrs

Thermal Radiation: Radiation spectrum; Black and gray surfaces; Emissive power, mono chromatic emissive power, emissivity; Kirchhoff's law, Planck's distribution law, Wein's displacement law

Radiative Heat Exchange Between Two Bodies: configuration factor; Large parallel plates, Equal parallel and opposite squares, rectangular plates perpendicular to each other; heat exchange between large parallel plates of different emissivity; gray body radiation – small bodies, large parallel plates, concentric cylinders and spheres, small body in a large enclosure, Concept of shape factor and surface resistances, radiation shields

Textbook(s):

1. R. C. Sachdeva, *Fundamentals of Engineering Heat and Mass Transfer,* 6th ed., New Delhi: New Age International Pvt. Ltd., 19th July, 2022. *(Chapters 1, 2, 3, 5, 6, 7, 8, 9, 10,11,12)*

Data Book:

1. C. P. Kothandaraman and S. Subramanian, *Heat and Mass Transfer Data Book*, 10th ed., New Delhi: New Age International Pvt. Ltd., 1st Jan, 2022

Reference Book(s):

1. J. P. Holman and Souvik Bhattacharyya, *Heat Transfer*, 10th ed., New Delhi: McGraw Hill Education (India) Pvt. Ltd., 2017.
2. Frank P. Incropera, David P. Dewitt, Theodore L. Bergman and Adrienne S. Lavine, *Incropera's Principles of Heat and Mass Transfer*, New Delhi: Wiley India Pvt. Ltd., 1 Jan, 2018.
3. Yunus A Cengel and Afshin J Ghajar, *Heat and Mass Transfer-Fundamentals and Applications*, 6th ed., New Delhi: McGraw Hill, 5th August 2020.
4. P.K. Nag, *Heat and Mass Transfer,* 10th ed., New Delhi: Tata McGraw Hill Education Pvt. Ltd., 2017.
5. P.S. Ghoshdastidar, *Heat Transfer*, 2nd ed., New Delhi*:* Oxford University Press, 2012.

Web and Video link(s):

1. https://www.youtube.com/playlist?list=PL5F4F46C1983C6785 *Heat and Mass Transfer by Prof. S. P. Sukhatme and Prof. U. N. Gaitonde, Department of Mechanical Engineering, IIT Bombay.*
2. https://archive.nptel.ac.in/courses/112/108/112108149/ *NPTEL Video Lecture on Heat Transfer by Prof. Prof. Pradip Dutta, IISC Bengaluru.*

Course Articulation Matrix (CAM):		**U24ME401: HEAT TRANSFER**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME401.1**	2	2	1	1	-	1	-	-	1	-	1	2	1
CO2	**U24ME401.2**	2	2	1	1	-	1	-	-	1	-	1	2	1
CO3	**U24ME401.3**	2	2	1	1	-	1	-	-	1	-	1	2	1
CO4	**U24ME401.4**	2	2	1	1	-	1	-	-	1	-	1	2	1
	U24ME401	**2**	**2**	**1**	**1**	**-**	**1**	**-**	**-**	**1**	**-**	**1**	**2**	**1**

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Evaluate critical radius of insulation & heat transfer through composite walls and fins	SDG4	Quality Education	Develops analytical, and engineering design skills essential for higher technical education and research.
CO2	analyze transient heat conduction and forced convection heat transfer for various flows	SDG4	Quality Education	Strengthens theoretical and practical understanding of forced convection
CO3	solve free convection, boiling, condensation and design of heat exchangers problems	SDG9	Industry, Innovation and Infrastructure	Numerical solutions improve engineering analysis and industrial simulations
CO4	estimate radiation heat transfer between black and gray bodies	SDG9	Industry, Innovation and Infrastructure	Supports sustainable infrastructure, environmental flow and efficient engineering system.

MACHINE DRAWING			
Class: B. Tech. IV – Semester		**Branch:** ME	
Course Code:	**U24ME402**	**Credits:**	**4**
Hours/Week (L-T-P- E):	**3-0-2-5**	**CIE:**	**60%**
Total Number of Teaching Hours:	**60 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,
(based on cognitive skills acquired from theory component)

CO1 : interpret industrial standards & drawing conventions and construct detailed drawings of threaded fasteners, foundation bolt & keys

CO2 : create detailed drawings of mechanical joints, couplings, & bearings by applying conventional drafting practices

CO3 : develop sectional & part drawings of mechanical components like milling machine tail stock, revolving centre & drill jig using standard conventions & orthographic projection techniques

CO4 : design complete assembly drawings of eccentric & screw jack and convert 2D technical data into functional 3D models while evaluating manufacturability based on industrial drafting standards

UNIT-I	9 Hrs

Fundamentals of Machine Drawing: Classification of machine drawing, Industrial standards: BIS, ASME, ISO; Conventional representation of standard machine elements, Limits, Fits, Tolerances and Surface roughness symbols

Fasteners: Screw fastening - screw thread nomenclature, Types of thread profiles; Bolted joints - hexagonal-headed bolt with nut and washer, Eye foundation bolt; Keys - representation of saddle key, Sunk keys

UNIT-II	9 Hrs

Cotter joints – Cotter joints with sleeve, Cotter joint with a Gib, Knuckle joint

Couplings- Butt muff coupling, Universal coupling

Bearings- Solid journal bearing, Footstep bearing

UNIT-III	9 Hrs

Part Drawings – Sectional Views and Part Drawings of Mechanical Components: Milling machine Tailstock, Revolving centre and Drill jig

UNIT-IV	9 Hrs

Assembly Drawings - Assembly drawings of eccentric and screw jack; Bill of Materials (BOM) preparation

Blueprint to Prototype & Industrial Standards - Conversion of 2D drawings into real-world models; Industrial case studies from Automotive, Aerospace and Manufacturing

Textbook(s):

1. Siddheswar, Kannaiah, and Sastry, *Machine Drawing*, 48th ed., New Delhi: McGraw-Hill Education, 2014. ISBN-13: 978-0074603376

Reference Book(S):

1. Narayana, Venkat Reddy, and Kannaiah, *Machine Drawing*, 3rd ed., New Delhi: New Age International, 2009. ISBN-13: 978- 8122419177.
2. N.D.Bhatt and V. M. Panchal, *Machine Drawing*, 46th ed., Anand: Charotar Publishing House, 2011. ISBN-13: 978- 93-80358-46-8..

Web and Video link(s):

https://nptel.ac.in/courses/112104031; *NPTEL Video Lecture on Computer Aided Engineering Design by Dr. Anupam Saxsena, Professor of ME, IIT Kharagpur.*

Course Articulation Matrix (CAM):		U24ME402: MACHINE DRAWING												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME402.1	2	1	1	-	-	-	-	1	1	1	1	1	1
CO2	U24ME402.2	2	1	1	-	-	-	-	1	1	1	1	1	1
CO3	U24ME402.3	2	1	1	-	-	-	-	1	1	1	1	1	1
CO4	U24ME402.4	2	1	1	-	-	-	-	1	1	1	1	1	1
U24ME402		2	1	1	-	-	-	-	1	1	1	1	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	interpret industrial standards & drawing conventions and construct detailed drawings of threaded fasteners, foundation bolt & keys	SDG 9	Industry, Innovation and Infrastructure	Understanding and applying industrial drawing standards promotes standardized engineering practices, which are essential for reliable industrial infrastructure, manufacturing quality, and technological development.
CO2	create detailed drawings of mechanical joints, couplings, & bearings by applying conventional drafting practices	SDG 9	Industry, Innovation and Infrastructure	Accurate drafting of machine elements supports efficient machine design, manufacturing, and maintenance, thereby strengthening industrial productivity and sustainable infrastructure development.
CO3	develop sectional & part drawings of mechanical components like milling machine tail stock, revolving centre & drill jig using standard conventions & orthographic projection techniques	SDG 4	Quality Education	The development of advanced engineering visualization and technical communication skills enhances students' competency in engineering design and lifelong learning, contributing to quality technical education.
CO4	design complete assembly drawings of eccentric & screw jack and convert 2D technical data into functional 3D models while evaluating manufacturability based on industrial drafting standards	SDG 12	Responsible Consumption and Production	Evaluating manufacturability and creating optimized assembly designs encourages efficient use of materials, reduction of design errors, and sustainable production practices aligned with responsible manufacturing principles.

FLUID MECHANICS AND HYDRAULIC MACHINES			
Class: B. Tech. IV -Semester		**Branch:** Mechanical Engineering	
Course Code:	**U24ME403**	**Credits:**	**4**
Hours/Week (L-T-P-O-E):	**2-1-0-3**	**CIE:**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40 %**

Course Learning Outcomes (COs):

After completion of this course, the students should be able to....

CO1: evaluate fluid properties using fundamental laws of fluid statics

CO2: analyze continuity, Euler's, Bernoulli's, impulse and momentum equation

CO3: estimate losses in pipes, force developed by different vanes & performance parameters of turbines

CO4: determine performance characteristics of reciprocating & centrifugal pumps

UNIT-I	**9 Hrs**

Fluid fundamentals: Classification of fluids, Fluid properties - density, Specific weight, Specific gravity, Specific volume, Viscosity, Capillarity, Vapour pressure, Compressibility, Surface tension, Cohesion and Adhesion

Fluid statics: Pascal's Law, hydrostatic Law, Measurement of pressure, manometers, Piezometer, U-tube differential manometer, Inverted differential manometer, Hydrostatic forces on submerged plane and curved surfaces, Buoyancy, submerged bodies

UNIT-II	**9 Hrs**

Fluid dynamics: Classification of fluid flow, continuity equation in one, two and three-dimensional flow, forces causing motion, control-volume analysis of mass, momentum and energy, fluid acceleration, Euler's equation of motion, Bernoulli's Equation, applications of Bernoulli's equation

Impulse and Momentum equation: Linear momentum equation, Application of linear momentum equation to forces on pipe bend, venturi meter, orifice meter, pitot tube, viscous flow of incompressible fluids.

UNIT-III	**9 Hrs**

Flow through pipes: Loss of head in pipes, expression for head loss due to major and minor losses in pipes, HGL and TEL lines, pipes in series and parallel, equivalent pipe

Concept of impact jets: Classification, force extracted by fixed inclined, curved, and moving blades, head losses, condition for maximum efficiency, various efficiencies

Hydraulic turbines: Concept of impact jets, classification, head, losses and various efficiencies, Pelton turbines, components, velocity triangles, power and efficiencies, reaction turbines, Francis and Kaplan turbines, efficiencies and characteristics, unit quantities, specific speed, draft tube theory

UNIT-IV	**9 Hrs**

Reciprocating pumps: Working of single and double-acting pumps, work done and efficiencies, Slip, Negative slip, performance characteristics of pumps.

Centrifugal pumps: Principle, components, work done and efficiency, pumps in series and in parallel, characteristics, cavitation.

Textbook:

1. P.N. Modi and S.M. Seth, *Hydraulics and Fluid Mechanics Including Hydraulic Machines*, 21st ed., Standard Book House, Rajsons Publications Private Limited, 2017.

Reference Book(s):

1 R. K. Bansal, *Fluid Mechanics and Hydraulic Machines*, Periodicals Private Ltd., 2018

2 Victor Streeter and E. Benjamin, Wylie, *Fluid Mechanics*, 9th ed., Singapore: McGraw Hill, 2017.

3 Frank M. White, *Fluid Mechanics*, Special Indian ed., New Delhi: Tata McGraw Hill, 2011.

4 A.K. Jain, *Fluid Mechanics Including Hydraulic Machines*, 12th ed., New Delhi: Khanna Publications, 2018.

Web and Video link(s):

1. **https://www.youtube.com/playlist?list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw** *NPTEL Video Lecture on* ***Fluid Mechanics*** *By Prof. Subashisa Dutta IIT Guwahati*
2. https://www.youtube.com/@fluidmachines5626/playlists *NPTEL Video Lecture on* ***Fluid Machines*** *By Prof. Suman Chakraborty IIT Kharagpur*

Course Articulation Matrix (CAM):		U24ME403: FLUID MECHANICS AND HYDRAULIC MACHINES												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME403.1	2	2	1	1	-	1	-	-	1	-	1	2	1
CO2	U24ME403.2	2	2	1	1	-	1	-	-	1	-	1	2	1
CO3	U24ME403.3	2	2	1	1	-	1	-	-	1	-	1	2	1
CO4	U24ME403.4	2	2	1	1	-	1	-	-	1	-	1	2	1
	U24ME403	**2**	**2**	**1**	**1**	**-**	**1**	**-**		**1**	**-**	**1**	**2**	**1**

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	evaluate fluid properties using fundamental laws of fluid statics	SDG-6 SDG-9	**Clean Water and Sanitation** Industry Innovation and Infrastructure	Understanding fluid properties and hydrostatic principles helps in the design of water storage systems, dams, pipelines, hydraulic structures, and sanitation systems. These concepts are essential for efficient water resource management and infrastructure development.
CO2	analyze continuity, Euler's, Bernoulli's, impulse and momentum equation	SDG-7 SDG-9	Affordable and Clean Energy Industry, Innovation and Infrastructure	Fluid flow analysis is fundamental in the design of energy-efficient systems such as turbines, pumps, pipelines, HVAC systems, and renewable energy devices. These principles improve industrial efficiency and sustainable infrastructure development.
CO3	estimate losses in pipes, force developed by different vanes & performance parameters of turbines	SDG-7 SDG-12	Affordable and Clean Energy Responsible Consumption and Production	Minimizing pipe losses and improving turbine efficiency contribute to energy conservation and optimal utilization of resources. Efficient hydraulic machinery reduces energy wastage and promotes sustainable industrial operations.
CO4	determine performance characteristics of reciprocating & centrifugal pumps	SDG-6 SDG-7 SDG-9	**Clean Water and Sanitation** Affordable and Clean Energy Industry, Innovation and Infrastructure	Pumps are widely used in irrigation, drinking water supply, wastewater treatment, and industrial fluid transport systems. Studying pump performance supports efficient water distribution, energy-efficient pumping systems, and sustainable infrastructure development.

DESIGN OF MACHINE ELEMENTS			
Class: B. Tech. IV – Semester		**Branch:** ME	
Course Code:	**U24ME404**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from theory component)

CO1 : apply engineering design principles to ensure static strength using Mohr's Circle & failure theories for stress analysis

CO2 : analyze fatigue strength and apply failure criteria to design solid & hollow shafts

CO3 : design and analyze keys, couplings, cotter joints, knuckle joints and bolted joints under various loading conditions

CO4 : design and analyze riveted & welded joints for static, varying and eccentric loads

UNIT-I	**9 Hrs**

Introduction: Engineering design, basic design procedure, basic requirements of machine elements, selection of materials for engineering applications; Design criterion

Design for Static Strength: Analysis of biaxial state of stress at a point, Principal stresses, Mohr's Circle representation of stresses; Theories of failure—maximum principal stress theory, maximum shear stress theory, maximum principal strain theory, maximum total strain energy theory, distortion energy theory and their applications

UNIT-II	**9 Hrs**

Design for Fatigue Strength: Types of fatigue loads, phenomenon of fatigue failure, endurance limit, stress concentration factor and its importance in design, notch sensitivity; Gerber's parabola, Goodman line, Soderberg equation and fatigue design under combined loading

Design of Shafts: Introduction, materials and design stresses; Design criterion for shafts, Design of solid and hollow shafts under combined loads

UNIT-III	**9 Hrs**

Design of Keys and Couplings: Types of keys, Design of sunk keys, and effect of keyways in sunk keys; Functions of couplings, Rigid and flexible couplings; Design of flange coupling and bush-pin type coupling

Cotter Joints: Design of socket and spigot type cotter joints; Design of knuckle joints. **Bolted Joints:** Stresses in screw fastenings—initial stresses, stresses due to external forces and stresses due to combined load; Bolts of uniform strength; Eccentrically loaded bolted joints. Stresses in screw fastenings—initial stresses, stresses due to external forces and stresses due to combined load; Bolts of uniform strength; eccentrically loaded bolted joints

UNIT-IV	**9 Hrs**

Riveted joints: Terminology, Different types of riveted joints, Failure modes, Design procedure; Boiler joints—longitudinal butt joint and circumferential lap joint; Structural joints—lozenge joint; Eccentrically loaded riveted joints

Welded joints: Conventional representation of welded joints; Butt and fillet welds under static and varying loads; Welded joints under eccentric loading

Textbook(s):

1. V.B. Bhandari, Design of Machine Elements, Tata McGraw-Hill, 4th edition, 2016, New Delhi

Reference Book(S):

1. J.E.Shigley and C.R.Mischke Mechanical Engineering Design, Tata McGraw Hill 6th edition, 2014, New Delhi.
2. N.C.Pandya and C. S. Shah, Machine Design, Charotar Publishing House, 20th edition, 2015, Anand.
3. R.L.Norton, Machine Design: An Integrated Approach, Pearson Education India, 3rd edition, 2013, Noida.
4. R.S.Kurmi & Guptha, A Text Book of Machine Design, S.Chand & Co, 34th edition, 2016, New Delhi
5. P. Kannaiah, Machine Design, Scitech Publication Pvt. Ltd., 15th edition, 2009, Chennai.

Web and Video link(s):

https://youtube.com/playlist?list=PL3D4EECEFAA99D9BE&si=CWLAYbTZ_v8DJGB3: Prof. B Maiti, Prof. G. Chakraborty, Department of Mechanical Engineering, IIT Kharagpur. Lecture Series on Design of Machine Elements – I

Course Articulation Matrix (CAM):		**U24ME404 : DESIGN OF MACHINE ELEMENTS**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME404.1**	2	2	2	2	-	-	-	1	1	1	1	2	1
CO2	**U24ME404.2**	2	2	2	2	-	-	-	1	1	1	1	2	1
CO3	**U24ME404.3**	2	2	2	2	-	-	-	1	1	1	1	2	2
CO4	**U24ME404.4**	2	2	3	3	-	-	-	1	1	1	1	2	2
U24ME404		2	2	2	2	-	-	-	1	1	1	1	2	1.5
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	apply engineering design principles to ensure static strength using Mohr's Circle and failure theories for stress analysis.	SDG9	Industry, Innovation and Infrastructure	Stress analysis and failure theories help in designing safe and reliable machine components used in industrial and infrastructure systems.
CO2	analyze fatigue strength and apply failure criteria to design solid and hollow shafts.	SDG9	Industry, Innovation and Infrastructure	Fatigue-based shaft design improves durability, efficiency, and reliability of rotating machinery in industrial applications.
CO3	design and analyze keys, couplings, cotter joints, knuckle joints, and bolted joints under various loading conditions.	SDG8	Decent Work and Economic Growth	Proper design of mechanical joints enhances machine safety, productivity, and sustainable industrial operations.
CO4	design and analyze riveted and welded joints for static, varying, and eccentric loads.	SDG11	Sustainable Cities and Communities	Reliable joint design ensures structural integrity and safety in construction, transportation, and infrastructure systems.

MACHINE TOOLS AND METROLOGY			
Class: B. Tech. IV –Semester		**Branch:** Mechanical Engineering	
Course Code:	**U24ME405**	**Credits:**	**3**
Hours/Week (L-T-P-O-E):	**2-1-0-3**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**36 Hrs**	**ESE :**	**40 %**

Course Learning Outcomes (COs):

After completion of this course, the students should be able to...

(based on cognitive skills acquired from theory component)

CO1: classify machine tools, interpret working principles and identify operations & applications of lathe, drilling, boring, shaper & planner machines

CO2: interpret working principles and identify operations & applications of milling machines, grinding machines and finishing operations

CO3: measure linear & angular dimensions using various instruments, design limit gauges using Taylor's principle and recommend suitable comparator for a given application

CO4: measure surface finish of a component & effective diameter of screw thread and make use of lasers & computers in measurement of dimensions & alignment testing

UNIT-I	9 Hrs

Machine Tools: Classification and applications

Lathe Machines: Working principle, Types, Constructional features, Specifications, Operations, attachments; Capstan and Turret lathe, Single spindle and multi-spindle automatic lathes

Drilling and Boring Machines – Working principles, Types, Constructional features, Specifications, Operations, Drilling time calculations, Twist drill; Types of boring machines and Applications

Shaper and Planer machines – Working principles, Types, Constructional features and Operations

UNIT-II	9 Hrs

Milling Machines – Working principles, Types, Constructional features, Operations, Geometry of milling cutters, Methods of indexing

Grinding Machines – Working principles, Types, Constructional features and Operations; Types of abrasives, Types of bonds, Selection of a grinding wheel

Finishing Operations - Working principles, Lapping, Honing and Super finishing operations; Constructional features

UNIT-III	9 Hrs

Line and end standards: Linear measurement – Vernier caliper, Micrometer and slip gauges; Angular measurement - sine bar and Angle gauges

Limits, fits and tolerances: Terminology, Types of fits, Hole and Shaft basis systems, Design of gauges, Taylor's principle for limit gauges; Limit gauges -plug, Ring and Snap gauges; Alignment tests for lathe

Comparators: Classification; Mechanical comparators - Johanson Mikrokater and Sigma comparator; Optical comparator- autocollimator; Interferometry - profile projector

UNIT-IV	9 Hrs

Metrology of surface roughness: Terminology; Methods of measurement of surface roughness; Principle and operation of Tomlinson surface meter and Taylor-Hobson Talysurf

Metrology of screw threads: Measurement of effective diameter using 2-wire and 3-wire method

Lasers in metrology - Advantages of lasers, Laser scan micrometers; Laser interferometers-Applications

Computer Aided Metrology - Basic concept of CMM, Types, Constructional features, Probes – accessories, Software, Applications, Three dimensional measuring machine**,** Machine vision

Textbook(s):

1. S.K. Hajra Chowdary, S. K. Bose and A.K. Hajra Chowdary, *Elements of Workshop Technology,* Vol. II, 15th ed., New Delhi: Media Promoter and Publishers Pvt. Ltd., India, 2019. (*Chapters 3,5,7,8.10,11 and 14*).
2. R. K. Jain, *Engineering Metrology*, 25th ed., New Delhi: Khanna publishers, 2005 (*Chapters 2 to 8, 10, 11, 14, 16, and 17).*

Reference Book(s):

1. I. C. Gupta, *A Textbook of Engineering Metrology*, 7th ed., New Delhi: Dhanpat Rai and Sons, 2018.
2. Henrich Gerling, *All about Machine Tools*, revised ed., New Delhi: New Age International, 2007.
3. Kalpakjian, S. and Steven R. Schmid, *Manufacturing, Engineering & Technology*, 4th ed., New Delhi: Pearson, 2001.
4. M. Mahajan, *A textbook of Metrology*, New Delhi: Dhanpat Rai & Co., 2016.
5. N. V. Raghavendra and L. Krishnamurthy, *Engineering Metrology and Measurements*, 1st ed., New Delhi: Oxford University Press, 2013.

Web and Video link(s):

1. https://archive.nptel.ac.in/courses/112/106/112106179/ *NPTEL Video Lecture on Metrology by Prof. Kanakuppi Sadhasivappa,Professor of ME, Bapuji Engineering and technology Devangiree.*
2. http://digimat.in/nptel/courses/video/112105233/L01.html *NPTEL Video Lecture on Metal cutting & Machine Tool by Prf. Asimava Roy Choudhury, Professor of ME, IIT, Kharagpur.*

Laboratory Manual (for laboratory component):

1. *Machine Tools and Metrology Laboratory Manual & Record Book,* Department of ME, KITSW.

Course Articulation Matrix (CAM): U24ME405 MACHINE TOOLS AND METROLOGY

CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	**U24ME405.1**	2	2	1	-	-	1	-	-	1	-	1	1	2
CO2	**U24ME405.2**	2	2	1	-	-	1	-	-	1	-	1	1	2
CO3	**U24ME405.3**	2	2	1	-	-	1	-	-	1	-	1	1	2
CO4	**U24ME405.4**	2	2	1	-	-	1	-	-	1	-	1	1	2
U24ME405		**2**	**2**	**1**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**1**	**1**	**2**

CO	CO Statement – The student should be able to…	Relevant SDG	SDG Description	Mapping Justification
CO1	Classify machine tools, interpret working principles and identify operations & applications of lathe, drilling, boring, shaper & planner machines	SDG 9	Industry, Innovation and Infrastructure	Understanding machine tools and their applications supports industrial development, precision manufacturing, and technological advancement in production systems.
CO2	Interpret working principles and identify operations & applications of milling machines, grinding machines and finishing operations	SDG 8	Decent Work and Economic Growth	Knowledge of machining and finishing operations enhances manufacturing productivity, technical competency, and industrial employability.
CO3	Measure linear & angular dimensions using various instruments, design limit gauges using Taylor's principle and recommend suitable comparator for a given application	SDG 12	Responsible Consumption and Production	Precision measurement and quality control reduce manufacturing defects, improve resource utilization, and ensure sustainable production practices.
CO4	Measure surface finish of a component & effective diameter of screw thread and make use of lasers & computers in measurement of dimensions & alignment testing	SDG 9	Industry, Innovation and Infrastructure	Advanced metrology techniques using lasers and computers improve accuracy, automation, and innovation in modern manufacturing and quality assurance systems.

MODELING LABORATORY			
Class: B. Tech. IV – Semester		**Branch:** ME	
Course Code:	**U24ME407**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : apply CAD software tools to create 2D sketches and develop 3D models of mechanical components, incorporating projection, dimensioning, and rendering techniques

CO2 : design and detail standard machine elements such as fasteners, joints, bearings and couplings, including exploded and sectional views for technical documentation

CO3 : interpret and construct multi-component assembly drawings with appropriate GD&T symbols, surface finish notations and dimensional tolerances

CO4 : evaluate the manufacturability and functionality of CAD models through 3D printing, and produce complete machine drawings aligned with industrial drafting standard

List of Experiments

1. Introduction to CAD Software – Basic sketching, projection, and dimensioning
2. Draft standard threaded fasteners – hexagonal bolts, screws, and riveted joints
3. Create detailed drawings of keys, cotter joints, and knuckle joints
4. Create exploded and sectional views of a shaft coupling
5. Develop CAD models of thrust bearing and radial bearing
6. Construct and interpret a multi-component gearbox assembly drawing
7. Draft a sectional view of a piston and connecting rod, identifying internal features and understanding their mechanical relationships
8. Convert 2D engineering drawings into 3D CAD models, applying materials and rendering techniques for design visualization
9. Draft dimensional tolerances, Geometric Dimensioning & Tolerance (GD&T) symbols, and surface finish symbols in CAD
10. Create a simple mechanical assembly containing housing with a sliding fit; assign tolerances to each part
11. Fabricate a small-scale mechanical part using a 3D printer, testing the accuracy and viability of the CAD design in real-world conditions
12. Develop a complete machine drawing based on an actual industrial application, incorporating all drafting standards, annotations and detailing

Textbook(s):

1. Sham Tickoo, AutoCAD 2017 for Engineers and Designers, 23rd ed., New Delhi, India: Dreamtech Press, Wiley Publisher, 2016. ISBN-13: 978- 9351199472.

Reference Book(S):

1. Sham Tickoo, Pro/ENGINEER PTC Creo Parametric 3.0 for Engineers and Designers, 3rd ed., New Delhi, India: Dreamtech Press, 2015. ISBN: 978-93-5119-810-9.
2. Sham Tickoo, CATIA V5-6R2017 for Designers, 15th ed., New Delhi, India: BPB Publications, 2018. ISBN: 978-93-5119-810-9

Laboratory Manual:

Modelling Laboratory Manual, Department of ME, KITSW.

Course Articulation Matrix (CAM):		U24ME407 : MODELING LABORATORY											
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME407.1	2	2	-	-	2	-	-	1	1	1	1	1	2
CO2	U24ME407.2	2	2	-	-	2	-	-	1	1	1	1	1	2
CO3	U24ME407.3	2	2	-	-	2	-	-	1	1	1	1	1	2
CO4	U24ME407.4	2	2	-	-	2	-	-	1	1	1	1	1	2
U24ME407		2	2	-	-	2	-	-	1	1	1	1	1	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	CO Statement *The student should be able to*	Relevant SDG	SDG Description	Mapping Justification
CO1	apply CAD software tools to create 2D sketches and develop 3D models of mechanical components, incorporating projection, dimensioning, and rendering techniques	SDG 4	Quality Education	The application of modern CAD tools enhances technical competency, digital design skills, and experiential learning, thereby promoting quality engineering education and industry-relevant skill development.
CO2	design and detail standard machine elements such as fasteners, joints, bearings and couplings, including exploded and sectional views for technical documentation	SDG 9	Industry, Innovation and Infrastructure	The development of accurate component models and technical documentation supports industrial design practices, product development, and innovation in manufacturing systems.
CO3	interpret and construct multi-component assembly drawings with appropriate GD&T symbols, surface finish notations and dimensional tolerances	SDG 9	Industry, Innovation and Infrastructure	Proficiency in assembly modeling and tolerance-based design promotes standardization, product quality, and reliable engineering systems essential for sustainable industrial infrastructure.
CO4	evaluate the manufacturability and functionality of CAD models through 3D printing, and produce complete machine drawings aligned with industrial drafting standards	SDG 12	Responsible Consumption and Production	Assessing manufacturability through prototyping and optimizing designs before production reduces material waste, minimizes design errors, and encourages sustainable manufacturing practices.

FLUID MECHANICS AND HYDRAULIC MACHINES LABORATORY			
Class: B. Tech. IV – Semester		**Branch:** ME	
Course Code:	**U24ME408**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : *identify various components of an IC engine*

CO2 : *analyze performance characteristics of an IC engine with constant and variable compression ratio*

CO3 : *determine coefficient of discharge through venturi meter & orificemeter and estimate losses through pipes*

CO4 : *compare performance of hydraulic turbines*

LIST OF THE EXPERIMENTS

1. Assembly and Disassembly of an IC engine
2. Performance test and heat balance test on conventional single-cylinder four-stroke, Compression Ignition Engine with Brake Drum Dynamometer
3. Performance test and heat balance test on conventional twin-cylinder, four-stroke, Compression Ignition engine with hydraulic dynamometer
4. Valve Timing Diagram of a single-cylinder four-stroke, Compression Ignition Engine
5. Performance test on single-cylinder, four-stroke Compression Ignition engine with Variable Compression Ratio
6. Performance test and heat balance test on computer-aided single-cylinder four-stroke, Compression Ignition Engine with eddy current Dynamometer
7. Determination of coefficient of head losses in pipes due to major and minor losses (sudden enlargement, sudden contraction and bend)
8. Determination of coefficient of discharge for given orifice meter and Venturi meter
9. Determination of coefficient of impact for a jet on given vane
10. Determination of performance characteristics of a Pelton Wheel
11. Determination of performance characteristics of a Francis Turbine
12. Determination of performance characteristics of a Centrifugal Pump

Textbook:

1 P.N. Modi and S.M. Seth, *Hydraulics and Fluid Mechanics Including Hydraulic Machines*, 21st ed., Standard Book House, Rajsons Publications Private Limited, 2017.

Reference Book(s):

1 R. K. Bansal, *Fluid Mechanics and Hydraulic Machines*, Periodicals Private Ltd., 2018

2 Victor Streeter and E. Benjamin, Wylie, *Fluid Mechanics*, 9th ed., Singapore: McGraw Hill, 2017.

3 Frank M. White, *Fluid Mechanics*, Special Indian ed., New Delhi: Tata McGraw Hill, 2011.

4 A.K. Jain, *Fluid Mechanics Including Hydraulic Machines*, 12th ed., New Delhi: Khanna Publications, 2018.

Web and Video link(s):

1. **https://www.youtube.com/playlist?list=PLwdnzlV3ogoV-ATGY2ptuLS9mwLFOJoDw** *NPTEL Video Lecture on* ***Fluid Mechanics*** *By Prof. Subashisa Dutta IIT Guwahati*
2. https://www.youtube.com/@fluidmachines5626/playlists *NPTEL Video Lecture on* ***Fluid Machines*** *By Prof. Suman Chakraborty IIT Kharagpur*

Laboratory Manual (for laboratory component):

1. *Fluid mechanics and hydraulic machines Laboratory Manual and Record Book,* Department of ME, KITSW.

Course Articulation Matrix (CAM):		U24ME408: FLUID MECHANICS AND HYDRAULIC MACHINES												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME408.1	2	2	1	1	-	1	-	1	1	-	1	2	1
CO2	U24ME408.2	2	2	1	1	-	1	-	1	1	-	1	2	1
CO3	U24ME409.3	2	2	1	1	-	1	-	1	1	-	1	2	1
CO4	U24ME409.4	2	2	1	1	-	1	-	1	1	-	1	2	1
U24ME408		**2**	**2**	**1**	**1**	**-**	**1**	**-**	**1**	**1**	**-**	**1**	**2**	**1**

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	*identify various components of an IC engine*	SDG 9	Industry, Innovation and Infrastructure	Knowledge of IC engine components forms the foundation for automobile, manufacturing, and mechanical industries.
CO2	*analyze performance characteristics of an IC engine with constant and variable compression ratio*	SDG 7 SDG– 12 SDG -13	Affordable and Clean Energy, Responsible Consumption and Production **and** Climate Action	Performance analysis of IC engines helps improve fuel efficiency, reduce emissions, and optimize energy utilization. Variable compression ratio technology contributes to cleaner combustion and sustainable energy practices, reducing environmental impact.
CO3	*determine coefficient of discharge through venturi meter & orifice meter and estimate losses through pipes*	SDG 9	Industry Innovation and Infrastructure	Accurate flow measurement and estimation of pipe losses are essential in water supply systems, irrigation networks, industrial fluid transport, and process industries. These concepts promote efficient fluid management and sustainable infrastructure systems.
CO4	*compare performance of hydraulic turbines*	SDG 9 SDG 13	Industry, Innovation and Infrastructure and Climate Action	Hydraulic turbines are major components in renewable hydropower generation. Comparing turbine performance supports efficient clean energy production, sustainable infrastructure development, and reduction of dependence on fossil fuels.

MACHINE TOOLS AND METROLOGY LABORATORY			
Class: B. Tech. IV– Semester		**Branch:** ME	
Course Code:	**U24ME409**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1:	perform suitable machining operation on lathe, slotter & shaper machines for a given component
CO2:	perform suitable machining operation on drilling & milling machines for a given component
CO3:	determine thread characteristics & taper angles using 3-wire method and angular instruments respectively
CO4:	carry out surface roughness measurement and alignment tests

LIST OF EXPERIMENTS

1. Perform step, taper and thread cutting on lathe machine
2. Perform eccentric turning on lathe machine
3. Perform a key way slot on rectangular block using slotter machine
4. Perform V-groove on cylindrical bar using shaper machine
5. Perform a contour cut on rectangular block using milling machine
6. Perform drilling and tapping on MS rod using drilling machine
7. Measurement of external taper angle of a component using bevel protractor and sine bar
8. Measurement of bore diameter, taperness and ovality using bore gauge
9. Measurement of screw thread characteristics using profile projector
10. Measurement of screw thread effective diameter using screw thread micrometer and 3-wire set
11. Measurement of surface roughness of a given component using digital surface roughness tester
12. Alignment tests for machine tools-Roundness of head stock spindle and flatness of lathe bed

Textbook(s):

1. S.K. Hajra Chowdary, S. K. Bose and A.K. Hajra Chowdary, *Elements of Workshop Technology,* Vol. II, 15th ed., New Delhi: Media Promoter and Publishers Pvt. Ltd., India, 2019. (*Chapters 3,5,7,8.10,11 and 14*).
2. R. K. Jain, *Engineering Metrology*, 25th ed., New Delhi: Khanna publishers, 2005 (*Chapters 2 to 8, 10, 11, 14, 16, and 17).*

Reference Book(S):

1. I. C. Gupta, *A Textbook of Engineering Metrology*, 7th ed., New Delhi: Dhanpat Rai and Sons, 2018.
2. Henrich Gerling, *All about Machine Tools*, revised ed., New Delhi: New Age International, 2007.
3. Kalpakjian, S. and Steven R. Schmid, *Manufacturing, Engineering & Technology*, 4th ed., New Delhi: Pearson, 2001.
4. M. Mahajan, *A textbook of Metrology*, New Delhi: Dhanpat Rai & Co., 2016. N. V. Raghavendra and L. Krishnamurthy, *Engineering Metrology and Measurements*, 1st ed., New Delhi: Oxford University Press, 2013.

Laboratory Manual (for laboratory component):

1. *Laboratory Manual (for laboratory component): Machine Tools and Metrology Laboratory Manual & Record Book, Department of ME, KITSW.*

Course Articulation Matrix (CAM): U24ME409 MACHINE TOOLS AND METROLOGY LAB													
CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	U24ME409.1	3	2	-	-	1	1	-	2	1	-	1	2	1
CO2	U24ME409.2	3	2	-	-	1	1	-	2	1	-	1	2	1
CO3	U24ME409.3	3	2	-	-	1	1	-	2	1	-	1	2	1
CO4	U24ME409.4	3	2	-	-	1	1	-	2	1	-	1	2	1
U24ME409		**3**	**2**	**-**	**-**	**1**	**1**	-	**2**	**1**	**-**	**1**	**2**	**1**

CO	CO Statement – The student should be able to…	Relevant SDG	SDG Description	Mapping Justification
CO1	Perform suitable machining operation on lathe, slotter & shaper machines for a given component	SDG 8	Decent Work and Economic Growth	Practical machining skills improve technical competency, industrial productivity, and employability in manufacturing sectors.
CO2	Perform suitable machining operation on drilling & milling machines for a given component	SDG 9	Industry, Innovation and Infrastructure	Machining operations support precision manufacturing, industrial development, and advancement of modern production technologies.
CO3	Determine thread characteristics & taper angles using 3-wire method and angular instruments respectively	SDG 12	Responsible Consumption and Production	Accurate measurement techniques ensure quality control, reduce material rejection, and promote efficient utilization of manufacturing resources.
CO4	Carry out surface roughness measurement and alignment tests	SDG 9	Industry, Innovation and Infrastructure	Surface and alignment testing improve product quality, machine efficiency, and reliability of industrial manufacturing systems.

ENVIRONMENTAL STUDIES

Class: B. Tech. IV – Semester		**Branch:** Common to all	
Course Code:	**U24CY411**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**2-0-0-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : identify the natural resources and practice their usage more equitably
CO2 : develop an action plan for sustainable alternatives and conserving biodiversity
CO3 : examine and perceive the solutions for the environmental pollution
CO4 : adapt issues involved in enforcement of environmental legislation and green methodology

UNIT-I	**9 Hrs**

The Multidisciplinary Nature of Environmental Studies: Definition, Scope and importance
Natural Resources: Forest Resources-Use and over exploitation of forests, Deforestation, Timber extraction, Mining, Dams and their effects on forests and tribal people; Water Resources-Use and over-utilization of surface and ground water, Floods, Drought, Conflicts over water; Mineral Resources-Environmental effects of extracting and using mineral resources; Energy Resources-Renewable and non-renewable energy sources, Use of alternate energy sources

UNIT-II	**9 Hrs**

Ecosystem and Biodiversity:
Ecosystem: Concepts of an ecosystem, Food chain, Food webs, Ecological pyramids, Energy flow in the ecosystem and ecological succession
Biodiversity and its Conservation: Introduction, Definition, Genetic, Species and ecosystem diversity, Value of biodiversity, Biodiversity in India, Hot spots of biodiversity, Man-wildlife conflicts, Endangered and endemic species of India; In-situ and Ex-situ conservation

UNIT-III	**9 Hrs**

Environmental Pollution: Global issues-Global climatic change, Greenhouse gases, Effects of global warming, Ozone layer depletion
International Conventions/Protocols: Earth summit, Kyoto protocol, Montreal protocol Environmental Pollution-Causes and effects of air, Water, Soil, Marine and noise pollution with case studies
Solid and Hazardous Waste Management: Introduction, Types, Effects of urban industrial and nuclear waste
Natural Disaster Management: Introduction to disaster, Management of disaster, Disaster management of flood, earthquake, cyclone and landslides
Role of information technology in environment and human health

UNIT-IV	**9 Hrs**

Social Issues and the Environment: Role of Individual and Society, Water conservation, Rain water harvesting
Environmental Protection/Control Acts: Air (prevention and control of pollution) act 1981, Forest conservation act (1980 and 1992), Wildlife protection act 1972, Environment protection act 1986, Issues involved in enforcement of environmental legislations
Green Methodology: Principles of green chemistry, Green methods in electronic production, Impact of electronic waste on public health and environment
The Sustainable Development Goals (SDGs): United Nations Sustainable Development Goals

Textbook(s):

1. Erach Bharucha, *Text Book of Environmental Studies for Under Graduate Courses*, 2nd Edn., Universities Press (India) Pvt. Ltd, *2013*

Reference Book(S):

1. Y. Anjaneyulu, *Introduction to Environmental Science*, B.S. Publications, 2004.

2. Gilbert M. Masters, *Introduction to Environmental Engineering & Science*, 3rd Edn., Prentice Hall of India,1991
3. Anubha Kaushik, C.P. Kaushik, *Environmental Studies*, 4th Edn., New Age International Publishers,2014
4. R. Rajagopalan, Environmental Studies from crisis to cure, Oxford University Press, 2nd Edn., 2011

Web and Video link(s):

1. https://archive.nptel.ac.in/noc/courses/noc22/SEM1/noc22-ch27/ video lecture on renewable energy resources by Prof. Vaibhav. V. Goud and Dr. R. Anandalakshmi, Dept. Of Chemical Engineering, Guwahati.
2. https://sdgs.un.org/goals; UN's webpage on 17 sustainable Development Goals
3. https://onlinecourses.nptel.ac.in/noc23_hs57/preview United Nations sustainable Development Goals

Course Articulation Matrix (CAM):		U26CY411: ENVIRONMENTAL STUDIES												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U26CY411.1	2	1	2	1	-	2	1	1	1	-	-	-	-
CO2	U26CY411.2	-	-	2	-	-	1	1	1	1	1	-	-	-
CO3	U26CY411.3	1	2	1	-	-	1	1	1	1	1	1	-	-
CO4	U26CY411.4	-	-	2	-	-	1	1	1	1	-	1	-	-
U26CY411		1.50	1.50	1.50	1.00	-	1.25	1.00	1.00	1.00	1.00	1.00	-	-
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	identify the natural resources and practice their usage more equitably	SDG 7 and 13	Affordable and Clean Energy and Climate Action	Natural Resources and their usage creates awareness about conservation and equitable use of natural resources. It promotes sustainable practices that help reduce environmental degradation and climate change impacts.
CO2	develop an action plan for sustainable alternatives and conserving biodiversity	SDG14 and 15	Life below water &; Life on Land	Conserving biodiversity focuses on conserving terrestrial, marine and aquatic ecosystems biodiversity through protection of forests, wildlife, and natural habitats. The action plan encourages sustainable land use and restoration of ecosystems, ensuring long-term conservation of biodiversity and environmental stability.
CO3	examine and perceive the solutions for the environmental pollution	SDG3	Good Health and Well-Being	Environmental pollution and its direct impact on human health such as respiratory diseases, waterborne infections, and toxicity-related disorders. It promotes awareness of pollution control measures that reduce exposure to harmful pollutants in air, water, and soil.
CO4	adapt issues involved in enforcement of environmental legislation and green methodology	SDG13	Climate Action	Environmental legislation and green methodology, promotes awareness of environmental legislation and green methodologies that help reduce pollution and greenhouse gas emissions. It encourages effective enforcement of environmental laws to mitigate climate change impacts and ensure sustainable practices.

THEORY OF MACHINES			
Class: B. Tech. IV-Semester (Exit)		**Branch:** Mechanical Engineering	
Course Code:	**U24ME412X**	**Credits:**	**03**
Hours/Week (L-T-P-E):	**2-0-2-4**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**32 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: basic concepts of links, kinematic pairs, kinematic chains, mechanisms, velocity and acceleration analysis, and instantaneous centers of rotation

LO2: inversions of kinematic chains and principles of gear trains

LO3: types of cams and followers, role of governors, and function of flywheels in mechanical systems

LO4: static and dynamic balancing, gyroscopic motion in two-wheelers

THEORY COMPONENT

UNIT-I	**4 Hrs**

Basic Concepts: Definition of statics, Kinetics, Kinematics and dynamics; Rigid body and Resistant body concepts; Links, Kinematic pairs and their classifications; Degree of freedom in mechanical systems; Types of kinematic chains and constrained motion; Classification of mechanisms

Velocity and acceleration analysis of slider crank mechanism using graphical method, Instantaneous centres of rotation and Kennedy's theorem

UNIT-II	**4 Hrs**

Inversions of Kinematic Chains: Four-bar chain—locomotive coupler, Beam engine, Pantograph; Single slider crank chain—pendulum pump, Rotary I.C. engine mechanism, Oscillating cylinder engine; Whitworth quick return mechanism, Quick return mechanism of shaper; Double slider crank chain—Scotch Yoke mechanism, Elliptical trammel, Oldham's coupling

Gear terminology and classifications; Fundamental law of gearing Types of gear trains—simple, Compound, Epicyclic

UNIT-III	**4 Hrs**

Introduction to Cams and Followers: Cam and follower terminology; Classification of cams and followers; Types of follower motions and displacement diagrams—uniform velocity, Simple harmonic motion, Uniform acceleration and retardation; Classification and working principles of governors; Sensitivity and stability analysis of governors; Function of flywheel for energy storage

UNIT-IV	**4 Hrs**

Balancing: Need for balancing in mechanical systems; Types of balancing—static and dynamic balancing; Balancing of rotating and reciprocating masses; Principles of gyroscopic motion and its application in two-wheelers

LABORATORY COMPONENT

List of Experiments

1. Study of Kinematic Links, Pairs, Chains, and Mechanisms
2. Analysis of Different Types of Kinematic Chains
3. Inversions of the Slider-Crank Mechanism
4. Construction of Displacement Diagram for a Cam-Follower Mechanism
5. Static and Dynamic Balancing of Rotary Masses
6. Controlling Force Diagram of Hartnell Governor
7. Verification of Gyroscopic Effect
8. Determination of Natural Frequency of a Spring-Mass System

Textbook(s):

1. S.S Rattan, *Theory of Machines*, 4th ed., New Delhi: McGraw-Hill, 2014.

Reference Book(s):

1. R.L.Norton, *Design of Machinery-An Introduction to the Synthesis and Analysis of Mechanisms and Machines*, 4th ed., New York: McGraw-Hill, 2008.
2. Ambekar, *Theory of Mechanisms and Machines*, New Delhi: Prentice Hall of India, 2007.
3. J.S.Rao and R.V. Dukkipati, *Theory of Mechanisms and Machine Theory*, 2nd ed., New Delhi: New Age International, 2006.
4. R.S.Kurmi and J.K.Guptha, *Theory of Machines*, 14th ed., New Delhi: S. Chand & Co., 2014

Web and Video link(s):

https://archive.nptel.ac.in/courses/112/106/112106270/ *NPTEL Video Lecture on* ***Kinematics of Machines, Prof. Ashok K Mallik,*** *IIT Kanpur*

Laboratory Manual (for laboratory component): *Theory of Machines Manual,* Department of Mechanical Engineering, KITSW.

Course Learning Outcomes (COs): Course Learning Outcomes (COs):
After completion of this course, the students should be able to,

(based on cognitive skills acquired from theory component)

CO1: understand fundamental concepts of links, kinematic pairs, kinematic chains, mechanisms, velocity and acceleration analysis, and instantaneous centers of rotation
CO2: describe inversions of kinematic chains and principles of gear trains with their applications
CO3: explain different types of cams and followers, role of governors, and function of flywheels in mechanical systems
CO4: illustrate principles of static and dynamic balancing, including gyroscopic motion in two-wheelers

(based on skills acquired from laboratory component)

CO5: analyze motion & behavior of kinematic systems, including links, pairs, chains and mechanisms
CO6: interpret and design mechanical systems such as kinematic chains, slider-crank mechanisms and cam-follower mechanisms
CO7: apply techniques to balance rotary masses and assess the effects of gyroscopic forces
CO8: determine natural frequency of spring-mass systems and apply this knowledge to practical engineering problems

Course Articulation Matrix (CAM):		**U24ME412X Theory of Machines**											
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME214X.1**	1	1	-	-	-	-	-	1	1	1	1	1	1
CO2	**U24ME214X.2**	1	1	-	-	-	-	-	1	1	1	1	1	1
CO3	**U24ME214X.3**	1	1	1	1	-	-	-	1	1	1	1	1	1
CO4	**U24ME214X.4**	1	1	1	1	-	-	-	1	1	1	1	1	1
CO5	**U24ME214X.5**	1	1	1	-	-	-	-	1	1	1	1	1	1
CO6	**U24ME214X.6**	1	1	1	-	-	-	-	1	1	1	1	1	1
CO7	**U24ME214X.7**	1	1	1	1	-	-	-	1	1	1	1	1	1
CO8	**U24ME214X.8**	1	1	1	1	-	-	-	1	1	1	1	1	1
	U24ME214X	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**1**	**1**	**1**	**1**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

WORKSHOP TECHNOLOGY			
Class: B. Tech. IV –Semester (Exit)		**Branch:** Mechanical Engineering	
Course Code:	**U24ME413X**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-0-2-4**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**32 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: workshop layouts, safety norms and carpentry shop

LO2: fitting and smithy shop

LO3: metals joining technique and foundry shop

LO4: sheet metal operations and machine tools

THEORY COMPONENT

UNIT-I	4 Hrs

Introduction: Introduction to various shops/sections and workshop layouts, Safety practices, Causes of accidents, General safety rules, Safety signs and symbols

Carpentry Shop: Carpentry tools & operations, Types of woods and its applications, Carpentry joints, Carpentry operations - marking, Sawing, Planning, Chiselling, Grooving, Boring, Joining, Wood turning

UNIT-II	4 Hrs

Fitting Shop: Fitting hand tools bench vice, Hammers, Chisels, Files, Hacksaw, Surface plate, Punch, V block, Angle plate, Try square, Marking block, Steel rule, Twist drills, Reamers, Tap set, Die set; Fitting operations

Smithy Shop: Tin Smithy - hammers, Stakes, Scissors & operations, Hearing, bending, Joining, Types of sheet metal joints and applications; Black smithy-introduction of forging tools and its operations

UNIT-III	4 Hrs

Foundry Shop: Hand moulding tools, Types of moulding boxes, Pattern materials - wood, Cast iron, Aluminium, Brass, Plastics, their uses and advantages, Types of moulding sands

Metal Joining Shop: Types of welding joint, Arc welding - Welding electrode, Filler rod, Fluxes, and Solders, Gas welding hand tools- welding torch, Welding tip, Pressure regulator, Oxygen and acetylene cylinders, Spark lighter

UNIT-IV	4 Hrs

Sheet metal: Hand tools snip, Shears sheet gauge, Straight edge, L square, scriber, Divider, Trammel, Punches, Pliers, Stakes, Groovers and Limit set

Machine Shop: Introduction to machine tools and operations, Basic machine tools - Lathe, Shaper, Drilling, Milling machine and CNC with basic operations and uses

LABORATORY COMPONENT

List of Experiments

1. Prepare mortise and tenon joint
2. Prepare a half round fit
3. Prepare a sand mould using two-piece pattern-dumbbell
4. Prepare a single V – Butt Joint using Arc welding
5. Prepare a pipe joint using Oxy-Acetylene gas welding
6. Perform step, taper and thread cutting operation on Lathe machine
7. Perform a V-groove on cylindrical bar using Shaper machine
8. Perform drilling and taping on MS rod using Drilling machine

Textbook(s):

1. H S Bawa, *Workshop Practice*, 2nd ed., Uttar Pradesh: McGraw Hill Education (India) Private Limited, 2017.
2. A K Sarathe, *Engineering Workshop Practice*, 1st ed., New Delhi: Khanna Book Publishing Company Pvt. Ltd., 2023.

Reference Book(s):

1. S A Hajra Choudhury, A K Hajra Choudhury and Nirjhar Roy, *Elements of Workshop Technology*, Vol-I (Manufacturing Processes), 9th ed., Mumbai: Media Promoters and Publishers 2010.
2. S A Hajra Choudhury, A K Hajra Choudhury and Nirjhar Roy, *Elements of Workshop Technology,* Vol-II (Machine Tools), 15th ed., Calcutta: Indian Book Distributing Co., 2010.
3. Rajender Singh, *Introduction to Basic Manufacturing Process & Workshop Technology*, 2nd ed., New Age International Pvt. Ltd. Publishers, 2010.
4. P. N. Rao, *Manufacturing Technology*, Volume-I, 5th ed., New Delhi: Tata McGraw-Hill, 2018.

Course Learning Outcomes (COs):

After completion of this course, the students should be able to...

(based on cognitive skills acquired from theory component)

CO1: identify safety practices, symbols and procedures to prevent accidents and perform various operations

CO2: apply different fitting tools to perform basic fitting operations and make use of tin smithy and black smithy operations

CO3: classify moulding sands and apply welding tools & consumables to perform arc and gas welding operations

CO4: demonstrate proper use of sheet metal tools in performing various operations and perform basic machining operations

(based on skills acquired from laboratory component)

CO5: apply suitable tools to prepare a mortise and tenon joint and a half round fit

CO6: apply basic gating system and produce a mould cavity for double piece pattern

CO7: select suitable welding process and build joints in welding trade

CO8: perform various machining operations on lathe, shaper and drilling machine

Course Articulation Matrix (CAM): U24ME413X WORKSHOP TECHNOLOGY														
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24ME413X.1**	2	1	1	1	-	-	-	1	-	1	1	1	1
CO2	**U24ME413X.2**	1	2	1	1	-	-	-	1	-	1	1	1	1
CO3	**U24ME413X.3**	2	1	1	1	-	-	-	1	-	1	1	1	1
CO4	**U24ME413X.4**	1	2	1	1	-	-	-	1	-	1	1	1	1
CO5	**U24ME413X.5**	1	1	1	1	-	-	-	1	-	1	1	1	1
CO6	**U24ME413X.6**	1	2	1	1	-	-	-	1	-	1	1	1	1
CO7	**U24ME413X.7**	1	1	1	1	-	-	-	1	-	1	1	1	1
CO8	**U24ME413X.8**	1	2	1	1	-	-	-	1	-	1	1	1	1
U24ME413X		**1.25**	**1.5**	**1**	**1**	**-**	**-**	**-**	**1**	**-**	**1**	**1**	**1**	**1**

REFRIGERATION SYSTEMS			
Class: B. Tech. IV –Semester (Exit)		**Branch:** Mechanical Engineering	
Course Code:	**U24ME414X**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-0-2-4**	**CIE :**	**60 %**
Total Number of Teaching Hours:	**32 Hrs**	**ESE :**	**40 %**

Course Learning Objectives (LOs):

This course will develop students' knowledge in /on…

LO1: methods of refrigeration and refrigerants
LO2: components of refrigeration systems and refrigeration cycles
LO3: vapor absorption refrigeration systems and equipment control
LO4: refrigeration system applications

THEORY COMPONENT

UNIT-I	4 Hrs

Refrigeration: Definition and importance of refrigeration; Applications in domestic, Commercial and Industrial fields; Historical development of refrigeration, Units of refrigeration

Methods of Refrigeration: Air refrigeration- open and dense air refrigeration systems; Bell-Coleman cycle

Refrigerants: Classification -Primary and secondary refrigerants; Desirable properties of refrigerants; Eco-friendly refrigerants - R134a, R600a, CO_2, NH_3, C_5H_{10}; Ozone depletion and global warming potential (ODP & GWP); Refrigerant handling and safety

UNIT-II	4 Hrs

Components of Refrigeration Systems: Basic components – compressor, Condenser, Expansion Devices and Evaporator

Refrigeration Cycles: Carnot refrigeration cycle; Vapor Compression Refrigeration Cycle (VCRC) - representation on h-s and T-s diagrams

UNIT-III	4 Hrs

Vapor Absorption Refrigeration System (VARS): Determination of COP; Types - aqua-ammonia; Lithium bromide – water, Electrolux; Comparison of vapor compression and vapor absorption

Refrigeration Equipment and Controls: Accumulators, Receivers, Driers, Oil separators Pressure and temperature control devices; Safety devices - HP/LP cut-outs, Thermostats, solenoid valves

UNIT-IV	4 Hrs

Refrigeration System Applications: Domestic refrigeration - Refrigerator, Deep freezer; Commercial refrigeration - Water coolers, Bottle coolers, Ice plants; Cold Storage - Design considerations; Transport Refrigeration

LABORATORY COMPONENT

List of Experiments

1. To determine the Coefficient of Performance of a vapor compression refrigeration system.
2. To evaluate the Coefficient of Performance of a vapor absorption refrigeration system
3. To analyze the components of an air conditioning tutor
4. To evaluate Coefficient of Performance of an air conditioning tutor
5. To study and analyze the properties of moist air using air-conditioning tutor
6. To determine the Coefficient of Performance of a window air-conditioning tutor
7. To evaluate the properties of air using window air-conditioning system
8. To determine performance of Vortex tube refrigeration system

Textbook:

1. Arora S.C. and S. Domkundwar, *A course in Refrigeration and Air Conditioning*, 3rd ed., New Delhi: Dhanpat Rai & Sons., Reprint-2018.

Data Book(s):

1. Mathur, M. L., and Mehta, F. S., *Refrigerant and Psychrometric Properties (Tables & Charts) SI Units*, Jain Brothers publishers, New Delhi, 2010.
2. Khurmi, R. S., and Gupta, J. K., *Refrigeration Tables with chart*, S. Chand publishers, New Delhi, 2008.

Reference Book(s):

1. Arora C.P., *Refrigeration and Air Conditioning*, 3rd ed., New Delhi: Tata McGraw-Hill, 2009
2. Wilbert F. Stoecker, Jerold W. Jones, *Refrigeration and Air Conditioning*, New Delhi: McGraw-Hill, 1982.
3. Roy J. Dossat, *Principles of Refrigeration*, 3rd ed., New Delhi: Prentice Hall International Paperback Editions, 1991.
4. *ASHRAE Hand Book*, McGraw-Hill, New York, 2009.

Web and Video link(s):

https://archive.nptel.ac.in/courses/112/105/112105129/; *NPTEL Video Lecture on Refrigeration and Air Conditioning, Prof. Ravi Kumar, Professor of ME, IIT Roorkee*

Laboratory Manual (for laboratory component):

Refrigeration Systems laboratory manual, Department of ME, KITSW

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from theory component)

CO1: explain the methods of refrigeration and properties of refrigerants
CO2: evaluate performance parameters of vapor compression refrigeration systems
CO3: analyze vapor absorption refrigeration system
CO4: recommend refrigeration system for a given application

(based on knowledge acquired from laboratory component)

CO5: draw the p-h diagram of a vapour compression of refrigeration system
CO6: evaluate the performance parameters of VARS system
CO7: interpret the coefficient of performance of a widow type air-conditioning system
CO8: analyse coefficient of performance of an air-conditioner tutor

Course Articulation Matrix (CAM): U24ME414X REFRIGERATION SYSTEMS													
CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	**U24ME414X.1**	2	2	1	1	-	1	-	-	1	-	1	2	1
CO2	**U24ME414X.2**	2	2	1	1	-	1	-	-	1	-	1	2	1
CO3	**U24ME414X.3**	2	2	1	1	-	1	-	-	1	-	1	2	1
CO4	**U24ME414X.4**	2	2	1	1	-	1	-	-	1	-	1	2	1
CO5	**U24ME414X.5**	2	2	1	1	-	1	-	1	1	-	1	2	1
CO6	**U24ME414X.6**	2	2	1	1	-	1	-	1	1	-	1	2	1
CO7	**U24ME414X.7**	2	2	1	1	-	1	-	1	1	-	1	2	1
CO8	**U24ME414X.8**	2	2	1	1	-	1	-	1	1	-	1	2	1
	U24ME414X	**2**	**2**	**1**	**1**	**-**	**1**	**-**	**1**	**1**	**-**	**1**	**2**	**1**

V SEMESTER

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	OE	U24OE501X	Open Elective-Sustainable Development Goals Basket (OE-SDG)	2	1	-	3	3
2	PCC	U24ME502	Refrigeration & Air Conditioning	2	1	-	3	3
3	PCC	U24ME503	Kinematics of Machinery	2	1	-	3	3
4	PCC	U24ME504	Artificial Intelligence and Machine Learning	2	1	-	3	3
5	PCC	U24ME505	Sustainable Energy Technology	2	1	-	3	3
6	IKSC	U24IK506B	Essence of Indian Traditional Knowledge	2	-	-	2	2
7	PCC	U24ME507	Theory of Machines Laboratory	-	-	2	2	1
8	PCC	U24ME508	Thermal Engineering Laboratory	-	-	2	2	1
9	PCC	U24ME509	AIML Applications Laboratory	-	-	2	2	1
10	ELC	U24ME510	Seminar	-	-	2	2	1
Total:				**12**	**5**	**8**	**25**	**21**
Additional Learning@:Maximum credits allowed for Honors/Minor				**-**	**-**	**-**	**-**	**05**
Total credits for Honors/Minor students:				**-**	**-**	**-**	**-**	**26**
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)				**-**	**-**	**-**	**-**	**-**

#MULTIDISCIPLINARY OPEN ELECTIVES: Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

@List of courses for additional learning through MOOCs towards Honors/Minor in Engineering shall be prescribed by the department under Honors/ Minor Curricula

Sustainable Development Goals Basket		
Sr. No.	**Course Code**	**Course Title**
1.	U24OE501A	Sustainable Waste Management and Circular Economy (Offered by CE Department)
2.	U24OE501B	Carbon Reduction and Net Zero (Offered by EEE Department)
3.	U24OE501F	Intelligent Imaging for Sustainable Engineering (Offered by ECE Department)
4.	U24OE501L	Sensors and Actuators for Sustainable Smart cities and Health care (Offered by ECI Department)
5.	U24OE501T	Object Oriented Programming through Java (Offered by IT Department)

Indian Knowledge System Courses (IKSC)		
Sr. No.	**Course Code**	**Course Title**
1.	U24IK506A	Universal Human Values-II
2.	U24IK506B	Essence of Indian Traditional Knowledge

SUSTAINABLE WASTE MANAGEMENT AND CIRCULAR ECONOMY			
Class: B. Tech. V – Semester		Branch: ME	
Course Code:	U24OE501A	Credits:	3
Hours/Week (L-T-P- E):	2-1-0-3	CIE:	60%
Total No of Teaching Hours:	36 Hrs	ESE:	40%

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: appraise the concept of waste management

CO2: analyze activities associated with the management of hazardous wastes

CO3: apply the concept of circular economy and conduct relevant research

CO4: create business models for sustainable development using complex aspects of circular economy.

UNIT-I	9 Hrs

Waste management: Introduction, context and overview of waste management, waste landscape in India, hierarchy of waste management, sources of waste and waste streams, challenges and opportunities in waste management.

Strategies for Waste management: Need for National Waste Management Strategies (NWMS), Concepts and principles, objectives, goals and targets, policy tools for waste management, process of developing NWMS, implementation of NWMS, roles and responsibilities of various sectors, supporting initiatives of public and private domains, International recommendations and mandates.

UNIT-II	9 Hrs

Elements of Hazardous waste management: Hazardous waste definition, sources, identification and classification, Collection, handling, storage and transport, Hazardous waste management rules and regulations, treatment technologies, Hazardous waste disposal, Hazardous waste landfills- Site selections, design and operation. Hazardous waste reduction, recycling and reuse, remediation of hazardous waste contaminated sites.

Management of different Hazardous waste:

Sources, Production, collection, segregation, treatment and disposal of hazardous wastes - plastic waste -biomedical waste- E-waste-nuclear waste- Global and Indian Context, Hazardous Waste Management Practices – Health and environmental effects, recycling, energy production, landfilling, other applications.

UNIT-III	9 Hrs

Introduction to Circular Economy: Linear Economy and its emergence, Economic and Ecological disadvantages of linear economy, Replacing Linear economy by Circular Economy, Development of Concept of Circular Economy, A differential - Linear Vs Circular Economy.

Characteristics of Circular Economy: Material recovery, waste reduction, reducing negative externalities, explaining butterfly diagram, concept of loops.

UNIT-IV	9 Hrs

Circular design, innovation and Assessment: Zero waste- Waste Management in context of Circular Economy, Circular design, Research and innovation, Life Cycle Assessment (LCA), Circular Business Models

Case Studies and Legal policy framework Business models, Solid Waste Management / Wastewater, Plastics: A case study, EPR: polluters pay principle, Industrial symbiosis/ Eco-parks, Role of governments and networks, Sharing best practices, Universal circular economy policy goals, India and CE strategy, ESG

Textbook(s):

1. Guidelines For National Waste Management Strategies: Moving from Challenges to Opportunities—UNEP-United Nations Institute for Training and Research-2013- *ISBN: 978-92-807-3333-4*
2. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition.
3. Integrated Solid Waste Management, Engineering Principles and Management Issues,
   Tchobanoglous G, Theisen H and Vigil SA, McGraw Hill Education, 2014, Indian Edition

Reference Book(S):

1. Guidelines For National Waste Management Strategies: Moving from Challenges to Opportunities—UNEP-United Nations Institute for Training and Research-2013- *ISBN: 978-92-807-3333-4*
2. National Waste Management Strategy 2020- Minister of Forestry, Fisheries and the Environment, Republic of South Africa
3. *Circular Economy: A Credit Point Course*, Proposed by International Council for Circular Economy (ICCE) New Delhi, In Collaboration with All India Council for Technical Education (AICTE) New Delhi.
4. The Circular Economy A User's Guide Walter R Stahel Routledge; 1st Edition (24 June 2019)
5. Circular Economy: (Re) Emerging Movement Shalini Goyal Bhalla Invincible Publisher
6. The Circular Economy Handbook: Realizing The Circular Advantage Peter Lacy, Jessica Long, Wesley Spindler Palgrave Macmillan UK
7. Waste to Wealth: The Circular Economy Advantage Peter Lacy, Jakob Rutqvist Palgrave Macmillan

Web and Video link(s):

1. *https://nptel.ac.in/courses/105105160 NPTEL Course on Integrated Waste Management for a Smart City (Municipal Solid Waste, C&D Waste, E-Waste, NWMS, Waste Hierarchy, Policy Tools, Composting, Landfilling) by Prof. Brajesh Kumar Dubey, IIT Kharagpur.*
2. *https://nptel.ac.in/courses/105105169 NPTEL Course on Electronic Waste Management – Issues and Challenges (E-Waste Generation, Biomedical, Plastic & Hazardous Waste Rules, Recycling, Landfill Design, Remediation) by Prof. Brajesh Kumar Dubey, IIT Kharagpur.*
3. *https://nptel.ac.in/courses/105103205 NPTEL Course on Municipal Solid Waste Management (Circular Economy Principles, Material Recovery, LCA, Butterfly Diagram, Waste Reduction & Loop Strategies) by IIT Guwahati.*
4. *https://onlinecourses.nptel.ac.in/noc25_ce122/preview NPTEL Course on Integrated Waste Management for a Smart City – 2025 Edition (Circular Business Models, EPR, Industrial Symbiosis, ESG, Zero-Waste Strategies, India CE Policy Framework) by Prof. Brajesh Kumar Dubey, IIT Kharagpur.*

Course Articulation Matrix (CAM):		**URR24OE501A-SUSTAINABLE WASTE MANAGEMENT AND CIRCULAR ECONOMY**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24OE501A.1**	2	1	1	1	-	1	1	1	-	1	1	1	1
CO2	**U24OE501A.2**	2	1	1	1	-	1	1	1	1	1	1	1	1
CO3	**U24OE501A.3**	2	2	2	1	-	1	1	1	1	1	1	1	1
CO4	**U24OE501A.4**	2	1	1	1	2	1	1	1	1	1	1	1	1
U24OE501A		**2**	**1.25**	**1.25**	**1**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	CO Statement The student should be able to…	Relevant SDG	SDG Description	Mapping Justification
CO1	appraise the concept of waste management	SDG 12	Responsible Consumption and Production	Appraising the waste management hierarchy, National Waste Management Strategies (NWMS), and policy tools for controlling waste streams directly promotes responsible consumption, sustainable production patterns, and significant reduction of waste generation across municipal, industrial, and hazardous waste sectors.
CO2	analyze activities associated with the management of hazardous wastes	SDG 11	Sustainable Cities and Communities	Analyzing collection, handling, treatment, landfill design, and regulatory compliance for hazardous wastes — including plastic, biomedical, e-waste, and nuclear waste — safeguards human health and environmental quality, contributing to the development of safe, resilient, and environmentally sustainable urban and industrial communities.
CO3	apply the concept of circular economy and conduct relevant research	SDG 9	Industry, Innovation and Infrastructure	Applying circular economy principles — material recovery, waste reduction, LCA, butterfly diagram, and loop strategies — and conducting innovation-driven research fosters sustainable industrial practices that decouple economic growth from resource depletion, supporting resilient and environmentally responsible industrial infrastructure.
CO4	Create business models for sustainable development using complex aspects of circular economy.	SDG 9	Industry, Innovation and Infrastructure	Creating circular business models — incorporating EPR, industrial symbiosis, eco-parks, zero-waste strategies, ESG frameworks, and India-specific CE policy goals — drives innovation-led, resource-efficient industry and contributes to inclusive, sustainable economic growth aligned with SDG 9 and the global circular economy agenda.

CARBON REDUCTION & NET ZERO

Class: B. Tech. V– Semester		**Branch:** ME	
Course Code:	**U24OE501B**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from theory component)

CO1 : explain climate change, greenhouse gas emissions, carbon footprint assessment, and the need for carbon reduction

CO2 : apply carbon accounting methodologies, life cycle assessment techniques, and sustainability reporting frameworks

CO3 : analyse carbon reduction technologies, renewable energy integration, energy efficiency measures, and circular economy practices

CO4 : evaluate net-zero strategies, carbon markets, ESG frameworks, and organizational decarbonization pathways

UNIT-I	**9 Hrs**

Climate Change and Carbon Footprint: Introduction to climate change – Global warming and its impacts – Greenhouse gases (GHGs) and emission sources – Carbon cycle and climate systems – National and international climate initiatives – Paris Agreement and COP framework – Carbon footprint concepts – Organizational, product, and personal carbon footprints – Carbon footprint calculation methodologies – Scope 1, Scope 2, and Scope 3 emissions – Need for carbon reduction and net-zero transition

UNIT-II	**9 Hrs**

Carbon Accounting and Sustainability Assessment: Carbon accounting principles and methodologies – Greenhouse Gas Protocol – Emission factors and inventory development – Monitoring, reporting and verification (MRV) systems – Life Cycle Assessment (LCA) methodology – Environmental impact assessment – Carbon disclosure frameworks – Sustainability reporting standards – ESG fundamentals – Corporate sustainability metrics and reporting practices

UNIT-III	**9 Hrs**

Carbon Reduction Technologies and Strategies: Energy efficiency technologies – Green buildings and sustainable infrastructure – Renewable energy systems for decarbonization – Electrification of transportation – Electric vehicles and charging infrastructure – Smart energy management systems – Waste management and circular economy concepts – Resource efficiency – Industrial decarbonization technologies – Carbon capture, utilization and storage (CCUS)

UNIT-IV	**9 Hrs**

Net Zero Pathways and Carbon Markets: Net-zero concepts and frameworks – Science-based targets – Net-zero roadmaps for organizations and cities – Carbon neutrality versus net zero – Carbon credits and carbon trading mechanisms – Voluntary and compliance carbon markets – ESG regulations and policy frameworks – Climate risk assessment – Sustainable finance and green investments – Case studies on net-zero implementation in industries and institutions

Textbook(s):

1. Barry Murphy and James G. Piper, C*arbon Accounting and Management for Sustainability*, Routledge
2. Catherine Richards and Andy Haines, *Carbon Reduction and Net Zero Transition*, Springer

Reference Book(S):

1. Chris Goodall, *What We Need To Do Now: For a Zero Carbon Future*, Profile Books.
2. Duncan Clark, *The Rough Guide to Ethical Living and Carbon Reduction*, Rough Guides.
3. National Academies of Sciences, *Accelerating Decarbonization of the U.S. Energy System*, National Academies Press.

4. Intergovernmental Panel on Climate Change (IPCC), *Climate Change Assessment Reports*.

Web and Video link(s):

1. NPTEL – Climate Change and Sustainability
2. UN Sustainable Development Goals Learning Platform
3. IPCC Knowledge Portal
4. International Energy Agency (IEA) Learning Resources

Course Articulation Matrix (CAM):		U24OE501B : CARBON REDUCTION & NET ZERO												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24OE501B.1	2	2	1	1	1	3	1	-	1	-	1	1	1
CO2	U24OE501B.2	2	3	2	2	3	2	1	-	1	-	2	2	2
CO3	U24OE501B.3	2	2	3	2	2	3	1	-	1	1	2	2	3
CO4	U24OE501B.4	2	3	3	2	2	3	2	-	1	2	2	1	2
U24OE501B		2.0	2.5	2.25	1.75	2.0	2.75	1.25	-	1.0	1.5	1.75	1.5	2.0
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	explain climate change, greenhouse gas emissions, carbon footprint assessment and the need for carbon reduction.	SDG13	Climate Action	Understanding climate change science and greenhouse gas emissions provides the foundation for climate action and supports efforts to reduce global warming impacts.
CO2	apply carbon accounting methodologies, life cycle assessment techniques and sustainability reporting frameworks.	SDG12	Responsible Consumption and Production	Carbon accounting and life cycle assessment promote efficient resource utilization, sustainable production systems, and environmental responsibility.
CO3	analyse carbon reduction technologies, renewable energy integration, energy efficiency measures and circular economy practices.	SDG7	Affordable and Clean Energy	Renewable energy technologies, energy efficiency improvements, and sustainable resource management contribute to clean and affordable energy systems.
CO4	evaluate net-zero strategies, carbon markets, ESG frameworks and organizational decarbonization pathways.	SDG9, SDG11	Industry, Innovation and Infrastructure; Sustainable Cities and Communities	Net-zero implementation requires innovative infrastructure, sustainable industrial practices, climate-resilient cities, and effective environmental governance.

INTELLIGENT IMAGING FOR SUSTAINABLE ENGINEERING

Class: B. Tech. V– Semester		**Branch:** ME	
Course Code:	**U24OE501F**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : discuss fundamental properties of an image & analyze relationships between pixels and transforms on image

CO2 : apply different filtering techniques in spatial domain and frequency domain to enhance digital images

CO3 : analyze various image compression algorithms

CO4 : apply morphological image processing techniques on objects present in input images to extract image components and discover various ways to segment the objects present in the input images

UNIT-I	**9 Hrs**

Introduction: Fundamental steps and components of digital image processing, image sensing and acquisition, sampling and quantization, representation of digital images, relationships between pixels-neighbourhood of a pixel, distance measures, arithmetic and logical operations on images.

Image Transforms: DCT, DFT**,** Walsh transform, Hadamard Transform, Haar transform and KL transform.

UNIT-II	**9 Hrs**

Intensity Transformations: Basic intensity transformation functions, Histogram processing.

Spatial Filtering: Fundamentals of spatial filtering, Smoothing spatial filters, Sharpening spatial filters, Combining spatial enhancement methods.

Filtering in Frequency Domain: Basics of filtering in the frequency domain, image smoothing using lowpass frequency domain filters, image sharpening using highpass filters.

UNIT-III	**9 Hrs**

Image Compression: Types of redundancy- coding redundancy, interpixel redundancy, psychovisual redundancy, fidelity criteria, image compression system model, lossless and lossy coding, huffman coding, LZW coding, arithmetic coding, run length coding, bit-plane coding, constant area coding, lossless and lossy predictive coding, JPEG 2000.

UNIT-IV	**9 Hrs**

Image Segmentation: Fundamentals, Point, Line and edge detection**,** Thresholding - global, multiple, variable and multi variable thresholding, region based segmentation- region growing, region splitting and merging.

Morphological Image Processing: Structuring element, erosion and dilation, opening and closing, hit-or-miss transformation, basic morphological algorithms.

Textbook(s):

1. Rafael C. Gonzalez, Richard E. Woods, *Digital Image Processing*, Pearson, 4th edition, 2018, New York. *(Chapters 1 to 4, 7 to 10)*

Reference Book(S):

1. Anil K. Jain, *Fundamentals of Image Processing*, Pearson, 1st edition, 2015, Chennai.
2. B. Chanda, D. Dutta Majunder, *Digital Image Processing and Analysis*, Prentice Hall of India, 2nd edition, 2011, New Delhi.
3. S. Sridhar, *Digital Image Processing*, Oxford University Press, 2nd edition, 2016, Noida.
4. Munesh C. Trivedi, *Digital Image Processing*, Khanna Book Publishing, 1st edition, 2014, New Delhi.

Web and Video link(s):

https://onlinecourses.nptel.ac.in/noc22_ee116/preview; *NPTEL Video Lecture on Dital Image Processing by Prof. Prabir Kumar Biaswas, Professor of EEE, IIT Kharagpur.*

Course Articulation Matrix (CAM):		U24OE501F : INTELLIGENT IMAGING FOR SUSTAINABLE ENGINEERING												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24OE501F.1	1	2	2	1	-	-	1	-	1	-	-	1	1
CO2	U24OE501F.2	2	2	2	2	-	-	1	-	1	-	2	1	1
CO3	U24OE501F.3	2	2	2	2	-	-	1	-	1	-	2	1	1
CO4	U24OE501F.4	2	2	3	3	-	-	1	-	1	-	2	1	1
U24OE501E		**1.75**	**2**	**2.25**	**1.75**	**-**	**-**	**1**	**-**	**1**	**-**	**2**	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	discuss fundamental properties of an image & analyze relationships between pixels and transforms on image	SDG 3, SDG 4, SDG 9 & SDG 11	Good Health and Well-being, Quality Education; Industry, Innovation and Infrastructure, Sustainable Cities and Communities	Enables applications in medical image analysis and diagnosis. Develops knowledge and analytical skills in image processing. Supports innovation in intelligent imaging and automation systems. Supports smart surveillance and traffic management applications.
CO2	apply different filtering techniques in spatial domain and frequency domain to enhance digital images.	SDG 3, SDG 4, SDG 9 & SDG 11	Good Health and Well-being, Quality Education; Industry, Innovation and Infrastructure, Sustainable Cities and Communities	Improves medical image quality for accurate diagnosis. Enhances practical knowledge of image enhancement techniques. Supports advanced imaging and industrial automation applications. Useful in surveillance, traffic monitoring, and smart city systems.
CO3	analyze various image compression algorithms	SDG 3, SDG 4, SDG 9 & SDG 11	Good Health and Well-being, Quality Education; Industry, Innovation and Infrastructure, Sustainable Cities and Communities	Enables efficient storage and sharing of medical images. Develops knowledge of image compression and data optimization techniques. Supports efficient storage and transmission in digital communication systems. Helps optimize multimedia and surveillance data in smart city applications.
CO4	apply morphological image processing techniques on objects present in input images to extract image components and discover various ways to segment the objects present in the input images	SDG 3, SDG 4, SDG 9 & SDG 11	Good Health and Well-being, Quality Education; Industry, Innovation and Infrastructure, Sustainable Cities and Communities	Assists in medical image segmentation for disease detection and diagnosis. Enhances practical understanding of image segmentation and analysis techniques. Supports automation, machine vision, and intelligent imaging applications. Useful in smart surveillance, object detection, and traffic monitoring systems.

SENSORS AND ACTUATORS FOR SUSTAINABLE SMART CITIES AND HEALTH CARE			
Class: B. Tech. V-Semester		**Branch:** ME	
Course Code:	**U24OE501L**	**Credits:**	**03**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: select appropriate sensors & actuators for smart system applications

CO2: utilize sustainable smart systems for smart cities, utility & industrial monitoring applications

CO3: select appropriate sensors & actuators for smart health care system applications

CO4: make use of enabling technologies like IoT, Cloud computing, AIML for sustainable smart cities and healthcare solutions

UNIT-I	**9 Hrs**

Introduction: Sustainable development goals (SDGs), Fundamentals of sensing and actuation, Smart technologies; Smart cities- Concept, Characteristics, Challenges**;** Smart healthcare ecosystem**-** Concept, Characteristics, Challenges

Sensors and Actuators: Sensor characteristics, Classification of sensors- Active, Passive**,** Analog, Digital sensors, Smart sensors; Actuator characteristics, Electrical actuators; Actuation systems- Automatic valves**,** Relays, Motor control**,** HVAC control

Interfacing of Sensors and Actuators - Data acquisition systems**,** Signal conditioning**,** ADC, DAC, Microcontroller interface

UNIT-II	**9 Hrs**

Smart Systems for Sustainable Smart Cities (*Block diagram approach*): Environmental Monitoring- Air quality monitoring, Water quality monitoring**,** Weather monitoring, Noise monitoring**;** Smart infrastructure- Smart lighting**,** Intelligent traffic management**,** Smart parking, Smart water distribution**,** Smart energy metering, Waste management

Smart Systems for Utility and Industrial Monitoring (*Block diagram approach*): Smart grid**,** Smart agriculture, Structural health monitoring

UNIT-III	**9 Hrs**

Sensors and Actuators in Healthcare: Temperature sensors**,** Blood pressure sensors**,** ECG sensors**,** Glucose sensor**,** Respiration sensor, EMG sensors**,** EEG sensors**,** Pulse oximeter, Drug delivery systems**,** Infusion pumps**,** Pacemakers**,** Prosthetic devices, Rehabilitation robots

Wearable Healthcare Devices: Fitness trackers**,** Smart watches**,** Continuous health monitoring**,** Fall detection systems

Telemedicine: Remote patient monitoring, Role of IoT, Cloud and AI in health care

UNIT-IV	**9 Hrs**

IoT and Cloud computing for Sustainable Smart Cities and Healthcare: IoT architecture**,** Communication Technologies- Wi-Fi**,** BLE**,** ZigBee**,** LoRaWAN**,** NB-IoT**,** 5G; Wireless sensor networks**,** Cloud computing applications; Green IoT and Energy Harvesting Techniques, Data privacy, Cybersecurity

AI for Sustainable Smart Cities and Healthcare: Machine learning for sensor data, Smart data analytics**,** Edge AI, Predictive maintenance**,** Introduction to AI-assisted diagnosis, Predictive healthcare

Textbook(s):

1. Priyanka Mishra and Ghanshyam Singh, *Sustainable, Smart Cities Enabling Technologies, Energy Trends and Potential Applications,* Switzerland, Springer Nature, *2023. (chapters 1,2,3,4,6,7)*
2. Jacob Fraden, *Handbook of Modern Sensors: Physics, Designs and Applications*, 5th Edition, Springer, 2016. *(Chapters 1,3,4,6 to 15, 17,18)*

Reference Book(s):

1. Arshdeep Bahga and Vijay Madisetti, *Internet of Things: A Hands-on Approach*, Universities Press, 2015.
2. John G. Webster, *Medical Instrumentation: Application and Design*, 4th Edition, Wiley India, 2010.
3. Raj Kamal, *Internet of Things: Architecture and Design Principles*, McGraw-Hill Education, 2017.
4. Ramon Pallas-Areny and John G. Webster, *Sensors and Signal Conditioning*, 3rd Edition, Wiley, 2012.

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc26_cs22; *NPTEL Video Lecture on Sensors and Actuators by Prof. Hardik Jeetendra Pandya, Professor of Electronic Systems Engineering, IISc Bangalore*
2. https://nptel.ac.in/courses/106105166; *NPTEL Video Lecture on Introduction to Internet of Things by Prof. Sudip Misra, Professor of CSE, IIT Kharagpur*
3. https://onlinecourses.nptel.ac.in/noc24_ee68; *NPTEL Video Lecture on Embedded Sensing, Actuation and Interfacing Systems, by Prof. Banibrata Mukherjee, Professor of Advanced Technology Development Centre (ATDC), IIT Kharagpur*

Course Articulation Matrix (CAM):		**U24OE501L: SENSORS AND ACTUATORS FOR SUSTAINABLE SMART CITIES AND HEALTH CARE**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24OE501L.1**	2	1	2	1	1	3	2	2	2	1	2	1	1
CO2	**U24OE501L.2**	2	1	2	1	1	3	2	2	2	1	2	1	1
CO3	**U24OE501L.3**	2	1	2	1	1	3	2	2	2	1	2	1	1
CO4	**U24OE501L.4**	2	1	2	1	2	3	2	2	2	1	2	1	1
U24OE501L		**2**	**1**	**2**	**1**	**1.25**	**3**	**2**	**2**	**2**	**1**	**2**	**1**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	select appropriate sensors & actuators for smart system applications	SDG4	Quality Education	✓ Can understand the working principles of sensors, actuators used in Smart systems ✓ Strengthens core engineering competencies, thereby promoting quality technical education and skill development essential for lifelong learning and professional growth
CO2	utilize sustainable smart systems for smart cities, utility & industrial monitoring applications	SDG11	Sustainable Cities and Communities	✓ Make use of sensor and actuator technologies which enables efficient environmental monitoring, intelligent transportation, smart energy management ✓ Make use of resource optimization to support the development of sustainable, safe, and resilient cities
CO3	select appropriate sensors & actuators for smart health care system applications	SDG3	Good Health and Well-being	✓ Can understand the working principles of sensors, actuators used in Health care systems ✓ Select appropriate sensors & actuators to develop smart systems for healthcare monitoring devices, diagnostic equipment, and patient safety systems that contribute to improved health and well-being
CO4	make use of enabling technologies like IoT, Cloud computing, AIML for sustainable smart cities and healthcare solutions	SDG9	Industry, Innovation and Infrastructure	✓ develop IoT/AIoT based smart systems which promotes technological innovation, smart infrastructure, digital connectivity, and sustainable industrial solutions for smart city and healthcare applications

OBJECT ORIENTED PROGRAMMING THROUGH JAVA

Class: B. Tech. V – Semester		**Branch: ME**	
Course Code:	**U24OE501T**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : illustrate object oriented concepts & Java programming features

CO2 : solve computing problems using classes, objects & inheritance concepts

CO3 : use polymorphism, interfaces & packages for developing objected oriented programs

CO4 : develop applications using exception handling, string handling, input & output operations

UNIT-I	**9 Hrs**

Fundamentals of Object Oriented Programming: Programming paradigms, Basic concepts of Object Oriented paradigm (OOP), benefits and applications of OOP

Basics of Java Language: Java language Features, Java Programming Structure, Java Tokens, JVM, Constants, Variables, Data types, Scope of variables, Type Casting, Operators and Expressions, Branching and looping statements, Arrays

UNIT-II	**9 Hrs**

Classes and Objects: Defining a class, Field declaration, Method declaration, Creating object, Accessing Class Members, Constructors, garbage collection, Static members, Nested and inner classes, Command line arguments, Wrapper classes

Inheritance: Extending a class, Defining subclasses, Subclass constructor, Multilevel inheritance, Hierarchical inheritance, Access controls, this and super keywords

UNIT-III	**9 Hrs**

Polymorphism: Overloading methods, Overloading constructors, Overriding Methods, Dynamic method dispatch, Abstract classes, Final Keyword

Interfaces: Defining an interface, Implementing interfaces, Nested Interfaces, Variables in interfaces, Extending interfaces

Packages: Packages, java API packages, Using System Packages, Naming Conventions, Creating Packages, Accessing Packages, Adding a class to package, Hiding classes, Static Import

UNIT-IV	**9 Hrs**

Exception handling: Fundamentals, Exception types, uncaught exceptions, Using try and catch, Multiple catch clauses, Explicit exceptions with throw, throws and finally keywords

String Handling: String constructors, string length, String operations, Character extraction, String comparison, Searching strings, modifying a string, changing string cases, Joining strings

I/O: I/O Basics, reading console Input, writing console output, Reading and writing files

Textbook(s):

1. Herbert Schildt, *Java The Complete Reference*, 9th ed. New Delhi : McGraw Hill Education (India) Pvt.Ltd , 2014.
2. E. Balagurusamy, *Programming with Java: A Primer*, 5th ed. New Delhi : McGraw Hill Education (India) Pvt.Ltd, 2014.

Reference Book(s):

1. P. Radha Krishna, *Object Oriented Programming through Java*, Hyderabad: Universities Press (India) Limited, 2011.
2. Kathy Sierra and Bert Bates, *Head First Java*, 2nd ed. USA: O"Reilly Media, Inc., 2005.
3. Uttam Kumar Roy, *Advanced Java Programming*, New Delhi: Oxford University Press India, 2015.

Web and Video link(s):

https://nptel.ac.in/courses/106105191 *NPTEL Video Lecture on Programming in Java by Prof. Debasis Samanta, Professor of CSE, IIT Kharagpur*

Course Articulation Matrix (CAM):		U24OE501T –OBJECT ORIENTED PROGRAMMING THROUGH JAVA												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24OE501T.1	1	-	-	-	-	-	-	-	-	-	1	1	1
CO2	U24OE501T.2	2	2	1	1	-	-	-	-	-	-	2	1	1
CO3	U24OE501T.3	2	2	1	1	-	-	-	-	-	-	2	1	1
CO4	U24OE501T.4	2	2	1	1	-	-	-	-	-	-	2	1	1
U24OE U24OE501T		**1.75**	**2**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**1.75**	**1**	**1**

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	illustrate object oriented concepts & Java programming features	**SDG 4**	**Quality Education**	The course provides fundamental programming knowledge and computational thinking skills, enabling learners to acquire quality technical education and lifelong learning competencies required in the digital era.
CO2	solve computing problems using classes, objects & inheritance concepts	**SDG 4**	**Quality Education**	Problem-solving through object-oriented design enhances analytical and logical thinking abilities, strengthening students' technical competence and professional readiness.
CO3	use polymorphism, interfaces & packages for developing objected oriented programs	**SDG 9**	**Industry, Innovation and Infrastructure**	Advanced object-oriented programming techniques support the development of scalable and maintainable software systems, contributing to innovation and modern digital infrastructure.
CO4	develop applications using exception handling, string handling, input & output operations	**SDG 9**	**Industry, Innovation and Infrastructure**	Application development skills enable students to create reliable software solutions for industrial, business, and societal needs, thereby promoting technological innovation and sustainable infrastructure.

REFRIGERATION AND AIR CONDITIONING			
Class: B. Tech. V – Semester		**Branch:** ME	
Course Code:	**U24ME502**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from the theory component)

CO1: evaluate the performance of the air & vapor compression refrigeration systems and describe the desirable properties of refrigerants

CO2 : illustrate the working principle of vapor absorption and non-conventional refrigeration systems

CO3: estimate the cooling load capacity for a given application

CO4: apply design considerations in refrigeration & air-conditioning applications

UNIT-I	9 Hrs

Methods of Refrigeration: Definition of refrigeration; units of refrigeration; evaporative refrigeration; air refrigeration - open and dense air refrigeration systems; Bell-Coleman cycle; necessity of providing air conditioning to the aircraft

Refrigerants: Classification; refrigerant nomenclature; properties of refrigerants- thermodynamic, physical, and safe working properties; global warming potential; ozone depletion potential

Vapor Compression Refrigeration Systems: Representation of vapor compression refrigeration cycle on P-h, T-s diagrams; types of vapor compression refrigeration system - wet versus dry compression, superheating, subcooling; effect of suction pressure and discharge pressure on COP

UNIT-II	9 Hrs

Vapor Absorption Refrigeration System: Determination of COP; types: aqua-ammonia; lithium bromide–water, Electrolux; comparison of vapor compression and vapor absorption refrigeration systems

Non-conventional refrigeration systems: Thermo-electric refrigeration system – working principle, comparison between thermo-electric and vapor compression refrigeration systems; Vortex tube – description, advantages, disadvantages, and applications

UNIT-III	9 Hrs

Psychrometry: Definition of air-conditioning; psychrometry- properties, relations, chart; processes-steam injection, water injection, adiabatic saturation, and chemical dehumidification; bypass factor; summer, winter, and year-round air conditioning systems; air washer

Cooling Load Calculations: Simple air-conditioning system-state and mass rate of supply air; summer air conditioning; apparatus dew point, with and without ventilation of air; purpose of ventilation; sensible heat factor- room, grand, and effective sensible heat factor

UNIT-IV	9 Hrs

Comfort Air conditioning: Requirements; factors governing optimum effective temperature; metabolic rate; mechanism of body heat loss

Pressure losses and duct sizing: Continuity equation; Bernoulli's equation; pressure losses; variation of pressure losses along a duct; system resistance; duct design methods

Applications of Refrigeration & Air Conditioning: Household refrigerators; comparison among window, split, and central air-conditioners; design considerations in air-conditioning of buses, theatres, hospitals, and cold storage

Textbook:

1. Arora S.C. and S. Domkundwar, *A course in Refrigeration and Air Conditioning*, 3rd ed., Dhanpat Rai & Sons., New Delhi, Reprint-2018

Reference Book(s):

1. Arora C.P., *Refrigeration and Air Conditioning*, Tata McGraw-Hill, 3rd edition, New Delhi, 2009
2. Wilbert F. Stoecker, Jerold W. Jones, *Refrigeration and Air Conditioning*, McGraw-Hill, New Delhi, 1982.

3. Roy J. Dossat, *Principles of Refrigeration*, Prentice Hall International Paperback Editions, 3rd ed., New Delhi, 1991.
4. *ASHRAE Handbook*, McGraw-Hill, New York, 2009.

Data Book(s):

1. Khurmi, R. S., and Gupta, J. K., *Refrigeration Tables with chart*, S. Chand Publishers, New Delhi, 2008.
2. Mathur, M. L., and Mehta, F. S., *Refrigerant and Psychrometric Properties (Tables & Charts) SI Units*, Jain Brothers Publishers, New Delhi, 2010.
3. C. P. Kothandaraman, P B Nagaraj and D Venkatesh, Refrigerant Tables and Charts including Air Conditioning Data, New Age International Publishers, New Delhi, 2006.

Web and Video link(s):

1. https://www.youtube.com/watch?v=nlsNmhiID74&list=PLJjrv2_3aFXdh1PQVeO1RRl_NmXiiPZh0; YouTube link for *Video Lecture on Refrigeration and Air-Conditioning by Prof. Ravi Kumar, Professor of Mechanical Engineering, IIT Roorkee.*
2. https://nptel.ac.in/courses/112105129; *NPTEL Weblink on Refrigeration and Air Conditioning by Prof. M. Ramgopal, Professor of Mechanical Engineering, IIT Kharagpur.*

Course Articulation Matrix (CAM):		**U24ME502: REFRIGERATION AND AIR CONDITIONING**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME502.1**	2	2	1	1	-	1	1	-	-	-	1	2	1
CO2	**U24ME502.2**	2	2	1	-	-	1	1	-	-	-	1	2	1
CO3	**U24ME502.3**	2	2	1	1	-	1	1	-	-	-	1	2	1
CO4	**U24ME502.4**	2	2	1	-	-	1	1	-	-	-	1	2	1
U24ME502		2	2	1	1	-	1	1	-	-	-	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	evaluate the performance of air and vapor compression refrigeration systems and describe the desirable properties of refrigerants	SDG 7	Affordable and Clean Energy	Promotes energy-efficient refrigeration technologies and the sustainable use of energy.
		SDG 13	Climate Action	Reduces greenhouse gas emissions through improved refrigerant selection and system efficiency.
CO2	illustrate the working principle of vapor absorption and non-conventional refrigeration systems	SDG 7	Affordable and Clean Energy	Supports alternative cooling technologies that use renewable or waste-heat sources.
		SDG 9	Industry, Innovation and Infrastructure	Encourages innovation in sustainable refrigeration system development.
CO3	estimate the cooling load capacity for a given application	SDG 11	Sustainable Cities and Communities	Supports efficient HVAC system planning for sustainable infrastructure.
		SDG 7	Affordable and Clean Energy	Optimizes energy demand and cooling efficiency.
CO4	apply design considerations in refrigeration and air-conditioning applications	SDG 11	Sustainable Cities and Communities	Promotes comfortable and energy-efficient building environments.
		SDG 13	Climate Action	Encourages environmentally responsible refrigeration and air-conditioning practices.

KINEMATICS OF MACHINERY			
Class: B. Tech. V-Semester		**Branch:** MED	
Course Code:	**U24ME503**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-0-1-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : *identify degrees of freedom of planar mechanisms; draw velocity polygons of planar mechanisms.*

CO2 : *draw and analyze acceleration polygons of planar mechanisms.*

CO3 : *draw the cam profiles for various follower motions and evaluate the velocity and acceleration of the follower.*

CO4 : *identify tooth profiles, interference of gear; simple, planetary gear trains and the differential gear box of an automobile and determine speed ratios of gear trains.*

UNIT-I	**9 Hrs**

Basic Concepts: Element, Link, kinematic pair, kinematic chain, mechanism, inversion, structure, machine, constrained motion; Grubbler's criterion, four-bar chain, Grashof's criterion; Inversions of four-bar, single-slider, and double-slider crank chains; steering gear mechanism.
Velocity Analysis: Relative Velocity Method; Instantaneous center Method, Aronhold-Kennedy Theorem of Three centers; Velocity Diagrams for four-bar mechanism, slider crank mechanism, combination of four bar and slider crank mechanism, quick return mechanisms.

UNIT-II	**9 Hrs**

Acceleration Analysis: Radial and Transverse Components of Acceleration; Coriolis Component of Acceleration; Acceleration Diagrams for four-bar mechanism, slider crank mechanism, combination of four-bar and slider crank mechanism & quick return mechanisms and Klein's construction

UNIT-III	**9 Hrs**

Cams: Classification of cams and followers; Displacement, velocity and acceleration diagrams for specified follower motion: uniform velocity, SHM, uniform acceleration and retardation, cycloidal motion; Generation of cam profiles with different types of followers: knife-edge, roller, and flat-faced; Reciprocating and oscillating types: radial and offset types. Analysis of motions of the follower for cams with specified contour: Roller follower on tangent cam.

UNIT-IV	**9 Hrs**

Toothed Gearing: Law of gearing; velocity of sliding; involute profile, path of contact, arc of contact; interference, methods to avoid interference, minimum number of teeth on pinion to avoid interference; involute and cycloidal tooth profiles, comparison.
Gear Trains: Simple, compound, reverted, epicyclic gear trains, Analysis of epicyclic gear train, torques in epicyclic gear trains, sun and planet gear, compound epicyclic gear trains, Bevel-epicyclic gear train, Wilson four-speed gear box and differential gear box of an automobile.

Textbook(s):

1. S.S Rattan, *Theory of Machines*, McGraw-Hill, 5th edition, 2019, New Delhi. (Chapters:1, 2, 3, 7, 10 and 12)

Reference Book(S):

1. R.L. Norton, *Design of Machinery-An Introduction to the Synthesis and Analysis of Mechanisms and Machines*, McGraw-Hill, 4th edition, 2008, New York.
2. Ambekar, *Theory of Mechanisms and Machines*, Prentice Hall of India, 2007, New Delhi.

3. J.S. Rao and R.V. Dukkipati, *Theory of Mechanisms and Machine Theory*, New Age International, 2nd edition, 2006, New Delhi.
4. R.S. Kurmi and J.K. Guptha, *Theory of Machines*, S. Chand & Co, 14th edition, 2014, New Delhi.
5. Thomas Bevan, *The Theory of Machines*, CBS Publishers, 3rd edition, 2005, New Delhi.

Web and Video link(s): .

https://nptel.ac.in/courses/112104121; NPTEL Video Lecture on Kinematics of Machines

By Prof. Ashok K Mallik, Professor of ME, IIT Kanpur.

Course Articulation Matrix (CAM):		**U24ME503: KINEMATICS OF MACHINERY**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME503**.1	2	2	2	1	-	-	-	-	1	1	1	2	2
CO2	**U24ME503** 2	2	2	2	2	-	-	-	-	1	1	1	2	2
CO3	**U24ME503**.3	2	2	1	1	-	-	-	-	1	1	1	2	2
CO4	**U24ME503**.4	2	2	2	2	-	-	-	-	1	1	1	2	2
U24ME503		2	2	1.75	1.5		-	-	-	1	1	1	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	*Identify degree of freedom of planar mechanisms; draw velocity polygons of planar mechanisms*	SDG 9	Industry, Innovation and Infrastructure	Understanding mechanism analysis and motion transmission contributes to the design and development of efficient industrial machines and mechanical systems.
CO2	*Draw and analyze acceleration polygons of planar mechanisms*	SDG 9	Industry, Innovation and Infrastructure	Acceleration analysis helps in improving the performance, safety, and reliability of mechanical systems used in industrial applications.
CO3	*Draw the cam profiles for various follower motions and evaluate velocity, acceleration of the follower*	SDG 12	Responsible Consumption and Production	Proper cam design improves machine efficiency, reduces wear and energy loss, and promotes sustainable manufacturing practices.
CO4	*Identify tooth profiles, interference of gear; simple, planetary gear trains and differential gear box of an automobile and determine speed ratios of gear trains*	SDG 9	Industry, Innovation and Infrastructure	Gear train analysis and design are essential for efficient power transmission systems in automobiles and industrial machinery, supporting technological advancement and infrastructure development.

Artificial Intelligence and Machine Learning

Class: B. Tech. V – Semester		**Branch:** ME	
Course Code:	**U24ME504**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from the theory component)

CO1: analyze fundamental artificial intelligence concepts, intelligent agents, and search strategies to solve computational problems

CO2: apply machine learning fundamentals, data preprocessing techniques and Python libraries for data analytics and visualization

CO3: apply and evaluate supervised and unsupervised machine learning techniques to build predictive and clustering models for solving practical data-driven problems

CO4: make use of neural networks, activation functions & optimization strategies to implement CNN

UNIT-I	**9 Hrs**

Introduction to Artificial Intelligence (AI): Definition, scope, history, applications and types of AI

Intelligent Agents: Agents and Environments, Structure of intelligent agents, Types of agent programs

Problem Solving in AI: Problem formulation—states, actions, goal test and path cost, Uninformed Search strategies—Breadth First Search (BFS), Uniform-Cost Search (UCS), Depth First Search (DFS), and Depth Limited Search, Iterative Deepening Depth First Search (IDDFS); Informed Search—Greedy Best-First Search and A* Search

UNIT-II	**9 Hrs**

Introduction to Machine Learning (ML): Definition, Applications, History, Difference between AI and ML, Types of ML

Data Pre-processing: Need for Data Pre-processing, Data Pre-processing Techniques - Data Cleaning, Data Integration, Data Transformation, Data Reduction; Implementing Data-Pre-processing in Python - Model selection, Training, Testing, Features scaling - Normalization, Standardization

UNIT-III	**9 Hrs**

Supervised Learning – Regression: Simple, Multiple, and Polynomial Linear Regression, Performance Metrics - Mean Absolute Error (MAE), Mean Squared Error (MSE), Root Mean Squared Error (RMSE) and R^2

Supervised Learning – Classification: Types, Algorithms - Decision Trees, Random Forest, Navie Bayes, k-Nearest Neighbor(k-NN), Logistic Regression, Support Vector Machine (SVM), Performance Metrics – Confusion Matrix, Accuracy, Precision, Recall and F1-score

Unsupervised Learning – Clustering: Introduction, Applications, Distance metrics; Partitioning clustering - k-means clustering

UNIT-IV	**9 Hrs**

Ensemble learning: Bagging - Random Forest, Stacking, Boosting - AdaBoost, XGBoost

Artificial Neural Network: Introduction, Biological vs Artificial neuron, Need for neural networks, Building Blocks of Neural Network - Neuron model, Weights, bias, Layers (input, hidden, output); Feed forward and back propagation; Activation Functions - Sigmoid, Tanh, ReLU, Softmax; Loss Functions - Cross-Entropy, Mean Absolute Error (MAE); Implementation of Convolution Neural Networks (CNN) – Building image Classifier with CNN; Dog-Cat Classifier

Optimizers & Training Process: Gradient Descent Approach, Stochastic Gradient Descent, Epochs, Iterations, Data Pre-processing for neural networks, Feature Engineering, over-fitting and under-fitting, Hyper parameters

Textbook(s):

1. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd Edition, Pearson, 2010 (*Chapter 1, 2, 3 and 18*)
2. Parteek Bhatia, *Machine Learning with Python*, Cambridge University Press, 2023. (*Chapter 1, 3, 4, 5, 7, 9, 12, 16 and 19*)

Reference Book(s):

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, 3rd edition, O'Reilly Media, 2022.
2. Sebastian Raschka, Vahid Mirjalili, *Python Machine Learning*, Packt Publishing Ltd., 3rd edition, 2019.
3. Andreas C. Müller, Sarah Guido, *Introduction to Machine Learning with Python – A guide for data scientists*, O'Reilly Media, 2016.

Web and Video link(s):

1. *https://nptel.ac.in/courses/106106126 NPTEL Video Lecture on Artificial Intelligence: Search Methods for Problem Solving by Deepak Khemani, Professor of Department of Computer Science and Engineering, IIT Madras.*
2. *https://nptel.ac.in/courses/106105152 NPTEL Video Lecture on Introduction to Machine Learning by Prof. Sudeshna Sarkar, Professor of CSE, IIT Kharagpur.*

Course Articulation Matrix (CAM):		**U24ME504: Artificial Intelligence and Machine Learning**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME504.1**	2	2	2	2	2	1	1	-	1	-	1	2	1
CO2	**U24ME504.2**	2	2	2	2	2	1	1	-	1	-	1	2	1
CO3	**U24ME504.3**	2	2	2	2	2	1	1	-	1	-	1	2	1
CO4	**U24ME504.4**	2	2	2	2	2	1	1	-	1	-	1	2	1
U24ME504		**2**	**2**	**2**	**2**	**2**	**1**	**1**	**-**	**1**	**-**	**1**	**2**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	analyze fundamental artificial intelligence concepts, intelligent agents, and search strategies to solve computational problems	SDG9	Industry, Innovation and Infrastructure	AI-based problem-solving and intelligent agent systems support automation and optimization in industrial and infrastructure applications
CO2	apply machine learning fundamentals, data preprocessing techniques and Python libraries for data analytics and visualization	SDG4	Quality Education	Machine learning enables intelligent educational systems and data-driven learning methods, improving education quality.
CO3	apply and evaluate supervised and unsupervised machine learning techniques to build predictive and clustering models for solving practical data-driven	SDG9	Industry, Innovation and Infrastructure	ML algorithms enable predictive analytics and automation in industrial and infrastructure applications
CO4	make use of neural networks, activation functions, and optimization strategies to implement CNN	SDG11	Sustainable Cities and Communities	Advanced machine learning models are used in smart city applications such as intelligent transportation, autonomous systems, energy optimization, and sustainable urban planning.

SUSTAINABLE ENERGY TECHNOLOGY			
Class: B. Tech. V – Semester		**Branch:** ME	
Course Code:	**U24ME505**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,
(based on cognitive skills acquired from the theory component)

CO1: classify non-conventional energy sources and solar energy technologies

CO2 : analyze the working mechanisms of wind, geothermal, and hydrogen energy

CO3: illustrate the methods to extract energy from fuel cells, ocean thermal energy, and tidal energy

CO4: analyze the working principle of biogas generation, magneto-hydrodynamic, thermo-electric, and thermo-ionic technologies

UNIT-I	**9 Hrs**

Introduction: Classification of energy sources; distinction between conventional and non-conventional sources of energy; present energy scenario in India

Solar Energy: Introduction; solar constant; solar radiation on the earth's surface; solar radiation geometry; solar radiation measuring devices- pyrheliometer, pyranometer, sunshine recorder; Solar thermal energy collectors – liquid flat plate, air heaters, collectors with booster mirrors and concentrating collectors, applications of solar thermal collectors - absorption air conditioning system, thermal water pump, furnace, chimney, distillation, pond and cooker; solar energy storage systems–thermal**,** sensible and latent heat

Solar Photovoltaic (SPV) Systems: Classification and principle of a SPV cell, basic SPV for power generation; PV cell technologies- single, multi-crystalline and thin film; SPV systems – merits, limitations, applications-street lighting, domestic lighting, battery charging, and water pumping

UNIT-II	**9 Hrs**

Wind Energy: Origin and nature of winds, principles of wind power, operation of a wind turbine, site selection characteristics; Wind Energy Conversion System (WECS)-basic components, classification, advantages and disadvantages

Geothermal Energy: Origin and types of geothermal energy- vapor dominated, liquid dominated, petro-thermal and hybrid systems, operational and environmental problems, applications

Hydrogen Energy: Basics of hydrogen energy, production methods, storage, transportation, and applications

UNIT-III	**9 Hrs**

Fuel Cell: Working principle, basic thermodynamics and electro-chemical principles, classification-phosphoric acid, alkaline, polymer electrolyte membrane, molten carbon, and solid oxide fuel cell; applications

Energy from Oceans: Ocean temperature difference; open, closed, and hybrid cycle; tidal energy- working principle, classification - single basin and double basin arrangement

UNIT-IV	**9 Hrs**

Bio Energy: Biomass conversion technologies - wet and dry processes; photosynthesis; biogas generation, classification of biogas plants, biogas from plant wastes, site selection for a gas plant; digester design considerations, methods for maintaining biogas production; utilization of biogas; biomass gasification - classification and applications of gasifiers

Magneto Hydro Dynamic (MHD) Power Generation: Open and closed MHD systems; design problems and developments, advantages

Thermoelectric & Thermo-ionic Power Generation: Thermoelectric effects; principle of thermoelectric power generation and thermo-ionic converter, applications

Textbook:

1. G.D. Rai, *Non-Conventional Energy Sources,* 6th ed., New Delhi: Khanna Publishers, 2017.

Reference Book(s):

1. Sukhatme, S. P., and Nayak, J. K., *Solar Energy: Principles of Thermal Collection and Storage,* 3rd ed., New Delhi: Tata McGraw-Hill India, 2009.
2. Khan B. H., *Non-Conventional Energy Resources*, 3rd ed., New Delhi: McGraw-Hill, 2017.
3. Duffie and Beckman, *Solar Engineering of Thermal Processes*, John Wiley & Sons, New York, 1991.
4. R.K. Rajput, *Non-Conventional Energy Sources and Utilization,* 2nd ed., S Chand and Company Ltd, New Delhi, 2019.
5. Rajesh K. Prasad, Ojha T.P., *Non-Conventional Energy Sources,* 4th ed., Jain Brothers, 2012.

Web and Video link(s):

1. https://nptel.ac.in/courses/112106318 *NPTEL Video Lecture on Sustainable Energy Technology by Prof. Sayak Banerjee, Professor of Mechanical and Aerospace Engineering, IIT Hyderabad.*
2. https://nptel.ac.in/courses/121106014 *NPTEL Video Lecture on Non-conventional energy Resources by Prof. Prathap Haridoss, Professor of Metallurgical and Materials Engineering, IIT Madras.*

Course Articulation Matrix (CAM):		U24ME505: SUSTAINABLE ENERGY TECHNOLOGY												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME505.1	2	-	1	-	-	2	-	-	1	-	1	2	1
CO2	U24ME505.2	2	-	1	-	-	2	-	-	1	-	1	2	1
CO3	U24ME505.3	2	-	1	-	-	2	-	-	1	-	1	2	1
CO4	U24ME505.4	2	-	1	-	-	2	-	-	1	-	1	2	1
U24ME505		2	-	1	-	-	2	-	-	1	-	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	classify non-conventional energy sources and solar energy technologies	SDG7	Affordable Clean Energy	Promotes understanding and adoption of renewable energy technologies, especially solar systems, for sustainable energy generation
		SDG13	Climate Action	Supports the reduction of fossil fuel dependence and greenhouse gas emissions through renewable energy awareness.
CO2	analyze the working mechanisms of wind, geothermal, and hydrogen energy	SDG7	Affordable and Clean Energy	Enhances knowledge of clean alternative energy systems for sustainable power production.
		SDG9	Industry, Innovation and Infrastructure	Encourages technological innovation and infrastructure development in renewable energy sectors.
CO3	illustrate the methods to extract energy from fuel cells, ocean thermal energy, and tidal energy	SDG7	Affordable and Clean Energy	Supports diversified renewable energy generation from advanced and sustainable technologies.
		SDG14	Life Below Water	Promotes responsible utilization of marine energy resources while considering ocean ecosystem sustainability.
CO4	analyze the working principle of biogas generation, magneto-hydrodynamic, thermo-electric, and thermo-ionic technologies	SDG12	Responsible Consumption and Production	Encourages sustainable resource utilization, waste-to-energy conversion, and efficient alternative energy systems.
		SDG13	Climate Action	Supports low-carbon energy technologies that reduce environmental impact and promote sustainable development.

ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE			
Class: B. Tech. V – Semester	**Branch:** ME		
Course Code:	U24IK506B	**Credits:**	**2**
Hours/Week (L-T-P-E):	**2-0-0-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : summarize the basic structure of Vedas, Upavedas, Vedanga, Upanga

CO2 : explain Vedas as principal source of knowledge for scientific inventions

CO3 : describe different yogasanas, breathing techniques, chakras, meditation and their benefits

CO4 : discuss the benefits of yoga as an effective tool for management of human crisis

UNIT-I	6 Hrs

Basic Structure of Indian Knowledge System:

Introduction, Vedas – origin, classification, structure, Rig Veda, Sama Veda, Yajur Veda, Atharva Veda, UpaVedas – DhanurVeda, SthapatVeda, GandharvaVeda, AyurVeda, Vedanga – Shiksha, Chanda, Vyakarna, Nirukta, Kalpa, Jyothisha, Upanga – Dharmashastra, Mimamsa, Tarkashastra, Purana

UNIT-II	6 Hrs

Modern Science and Indian Knowledge System:

Introduction, Vedas as basis for modern science, architectural developments, medicine and its relevance, mathematical sciences in Vedas, space and military related developments, chemical sciences

UNIT-III	6 Hrs

Yoga and Holistic Health Care:

Healthy mind in healthy body, yoga: definition, types, yoga to keep fit: diet, yoga asanas, fundamentals, breathing techniques in Patanjali yoga tradition, pranayama, chakras, meditation, benefits of yoga – physical health, emotional health, prevention of disease, reducing or alleviating symptoms of problems.

UNIT-IV	6 Hrs

Case Studies – Yoga Practice:

Yoga as an effective tool for management of human crisis – depression, self-concept & mental health, yoga for stress management, yoga: a way to cure for insomnia.

Requisite: Yoga practice sessions are to be conducted for all students taking this course by the time they complete Unit 1 and Unit 2.

Textbook(s):

1. Sathish Chandra Chaterjee, Dhirendramohan Datta, *An Introduction to Indian Philosophy*, New Delhi: Rupa Publications Pvt. Ltd. (Chapter 2, 3).
2. Priyadaranjan Ray, S.N. Sen, *The Cultural Heritage of India*, Vol. 6, Science and Technology, Kolkata: The Ramakrishna Mission Institute of Culture.
3. *Yoga Sutra of Patanjali*, Kolkata: Ramakrishna Mission.
4. RN Jha, *Science of Consciousness Psychotherapy and Yoga Practices*, New Delhi: Vidyanidhi Prakasham, 2016 (Chapter 4, 5, 6, 7, 8).

Reference Book(S):

1. Swami Jitatmananda, *Holistic Science and Vedanta,* Mumbai: Bharatiya Vidya Bhavan (Chapter 2, 3).

Web and Video link(s):

1. NPTEL courses on Indian Philosophy, Yoga and Vedic Sciences available at https://onlinecourses.nptel.ac.in

Course Articulation Matrix (CAM):		U24IK506B: ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE													
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2
CO1	U24IK506B.1	-	-	-	-	-	1	-	2	1	1	-	-	-	-
CO2	U24IK506B.2	-	-	-	-	-	1	1	2	1	1	-	-	-	1
CO3	U24IK506B.3	-	-	-	-	-	1	-	2	2	1	-	2	-	-
CO4	U24IK506B.4	-	-	-	-	-	1	1	2	2	1	-	2	-	-
U24IK506B		-	-	-	-	-	1	1	2	1.5	1	-	2	-	1
		3 – HIGH, 2 – MEDIUM, 1 - LOW													

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	summarize the basic structure of Vedas, Upavedas, Vedanga, Upanga	SDG4	Quality Education	Understanding the foundational structure of Indian knowledge systems supports holistic education, critical thinking, and cultural literacy, contributing to quality and inclusive education.
CO2	explain Vedas as principal source of knowledge for scientific inventions	SDG9	Industry, Innovation and Infrastructure	Recognizing Vedic contributions to science and technology highlights indigenous innovation in areas such as mathematics, architecture and medicine, inspiring modern sustainable technological development.
CO3	describe different yogasanas, breathing techniques, chakras, meditation and their benefits	SDG3	Good Health and Well-being	Knowledge of yoga, pranayama, and meditation directly promotes physical health, mental well-being, and disease prevention, supporting the SDG goal of ensuring healthy lives for all.
CO4	discuss the benefits of yoga as an effective tool for management of human crisis	SDG3	Good Health and Well-being	Understanding yoga as a therapeutic tool for depression, stress, and insomnia contributes to mental health management and holistic wellness, aligning with SDG3 targets on mental health.

THEORY OF MACHINES LABORATORY

Class: B. Tech. V – Semester		**Branch:** ME	
Course Code:	**U24ME507**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on psychomotor skills acquired from laboratory component)

CO1: analyze and verify Coriolis acceleration, cam-follower motion characteristics, and gyroscopic effects using experimental methods.

CO2 : evaluate the static and dynamic balancing characteristics of rotating systems and analyze the controlling force behavior of governors.

CO3: determine and interpret the vibration behavior, natural frequency, damping characteristics, and critical speed of shafts.

CO4: simulate and analyze the kinematic characteristics of slider-crank and four-bar mechanisms using MATLAB-based computational tools.

LIST OF EXPERIMENTS

1. To determine Coriolli's Component of Acceleration experimentally & theoretically
2. To draw the curves for displacement, velocity, and acceleration vs angle of rotation for a given cam-follower combination.
3. To verify the relations of the gyroscopic effect.
4. To Perform Static and dynamic balancing of the rotating mass system.
5. To draw the controlling force diagrams of the Hartnell governor
6. To study the undamped free vibrations of an equivalent spring mass system.
7. To study of damped Torsional vibrations of a single Rotor shaft system
8. To study the forced lateral vibrations of the beam for different damping conditions.
9. To verify Dunkerly 's rule and to study the whirling phenomenon in shafts.
10. To study the free vibrations of a two-rotor system and to determine the natural frequency of vibration theoretically and experimentally.
11. Computational analysis and plotting of displacement, velocity and acceleration characteristics of the slider-crank mechanism using MATLAB.
12. Simulation and analysis of displacement, velocity and acceleration of four-bar linkage using MATLAB.

Textbook(s):

1. S. S. Rattan, *Theory of Machines*, McGraw-Hill Education, 4th edition, 2014, New Delhi.

Reference Book(S):

1. A. Ghosh and A. K. Mallik, *Theory of Mechanisms and Machines*, East-West Press, 3rd edition, 2006, New Delhi, India.
2. J. S. Rao and R. V. Dukkipati, *Mechanism and Machine Theory*, New Age International Publishers, 2nd edition, 2007, New Delhi, India.
3. R. S. Khurmi and J. K. Gupta, *Theory of Machines*, S. Chand Publishing, 14th edition, 2005, New Delhi, India.

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc22_ee116/preview; *NPTEL Video Lecture on Kinematics of Mechanisms and Machines by Prof. Anirvan DasGupta, Professor of ME, IIT Kharagpur.*
2. https://onlinecourses-archive.nptel.ac.in/noc18_me18/preview; *NPTEL Video Lecture on Dynamics of Machines by Prof. Amitabha Ghosh, Professor of ME, IIT Kanpur.*

Laboratory Manual (for laboratory component):

1. *Theory of Machines Laboratory Manual,* Department of ME, KITSW

Course Articulation Matrix (CAM):		U24ME507: THEORY OF MACHINES LABORATORY												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME507.1	2	2	2	2	-	-	-	2	2	1	1	2	2
CO2	U24ME507.2	2	2	2	2	-	-	-	2	2	1	1	2	2
CO3	U24ME507.3	2	2	2	2		-	-	2	2	1	1	2	2
CO4	U24ME507.4	2	2	2	2	2	-	-	2	2	1	1	2	2
U24ME507		2	2	2	2	2	-	-	2	2	1	1	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	analyze and verify Coriolis acceleration, cam-follower motion characteristics, and gyroscopic effects using experimental methods.	SDG 9	Industry, Innovation and Infrastructure	Develops fundamental analytical and experimental skills required for the design and improvement of efficient mechanical systems and industrial technologies.
CO2	evaluate the static and dynamic balancing characteristics of rotating systems and analyze the controlling force behavior of governors.	SDG 12	Responsible Consumption and Production	Promotes efficient machine operation with reduced vibration, wear, and energy losses, supporting sustainable industrial practices and resource utilization.
CO3	determine and interpret the vibration behavior, natural frequency, damping characteristics, and critical speed of shafts.	SDG 9	Industry, Innovation and Infrastructure	Supports the safe operation, reliability, and performance improvement of rotating shafts and mechanical systems used in industrial infrastructure.
CO4	simulate and analyze the kinematic characteristics of slider-crank and four-bar mechanisms using MATLAB-based computational tools.	SDG 4	Quality Education	Encourages the application of modern computational tools and simulation techniques to enhance engineering education and technical competency.

THERMAL ENGINEERING LABORATORY

Class: B. Tech. V – Semester		**Branch:** ME	
Course Code:	**U24ME508**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: analyse the thermal conductivity of the metal rod, composite walls & convective heat transfer coefficient of vertical surface, and emissivity of grey body

CO2: calculate the efficiency and effectiveness of pin fin and heat exchangers

CO3: determine the COP of the vapor compression, vortex tube refrigeration system, and window air conditioning system

CO4: evaluate the performance parameters of solar water and air heating systems

LIST OF EXPERIMENTS

1. Determine the thermal conductivity of the metal rod.
2. Evaluate overall thermal resistance and heat transfer rate through composite walls.
3. Estimate free convection heat transfer coefficients for a vertical surface.
4. Determine the emissivity of non-black body surfaces.
5. Evaluate the pin fin efficiency and effectiveness by forced convection.
6. Determine the effectiveness and overall heat transfer coefficients of a parallel and counter-flow heat exchangers.
7. Determine the COP of a vapor compression refrigeration system.
8. Evaluate the cooling performance and COP of a window air-conditioning system.
9. Investigate cooling and heating effects in a vortex tube refrigeration system.
10. Evaluate the performance parameters of the solar water heating system.
11. Evaluate the performance parameters of the solar air heating system.
12. Determine the efficiency of a solar flat plate collector for different tilt angles.

Textbook (s):

1. R. C. Sachdeva, *Fundamentals of Engineering Heat and Mass Transfer*, 5th ed. New Delhi: New Age International Pvt. Ltd., 2015.
2. Arora S.C. and S. Domkundwar, *A course in Refrigeration and Air Conditioning*, 3rd edition, Dhanpat Rai & Sons., New Delhi, Reprint-2018.
3. G.D. Rai, *Non-Conventional Energy Sources*, 6th ed., New Delhi: Khanna Publishers, 2017.

Reference Book(s):

1. Arora C.P., *Refrigeration and Air Conditioning*, Tata McGraw-Hill, 3rd ed. New Delhi: 2009
2. Wilbert F. Stoecker, Jerold W. Jones, *Refrigeration and Air Conditioning*, McGraw-Hill, New Delhi: 1982.
3. Sukhatme, S. P., and Nayak, J. K., *Solar Energy: Principles of Thermal Collection and Storage*, 3rd ed., New Delhi: Tata McGraw-Hill India, 2009.
4. Rajesh K. Prasad, Ojha T.P., *Non-Conventional Energy Sources*, 4th ed., Jain Brothers, 2012.
5. R.K. Rajput, *Non-Conventional Energy Sources and Utilization*, 2nd ed., S Chand and Company Ltd., New Delhi: 2019.

Data Book(s):

1. C. P. Kothandaraman and S. Subramanian, *Heat and Mass Transfer Data Book*, 9th ed. New Delhi: New Age International Pvt. Ltd., 2018.
2. Mathur, M. L., and Mehta, F. S., *Refrigerant and Psychrometric Properties (Tables & Charts) SI Units*, Jain Brothers Publishers, New Delhi, 2010.

Laboratory Manual (for laboratory component):

1. *Thermal Engineering Laboratory Manual,* Department of ME, KITSW

Course Articulation Matrix (CAM): U24ME508 THERMAL ENGINEERING LABORATORY													
CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	U24ME508.1	2	1	1	1	-	1	1	1	1	-	1	1	1
CO2	U24ME508.2	2	1	1	1	-	1	1	1	1	-	1	1	1
CO3	U24ME508.3	2	1	1	1	-	1	1	1	1	-	1	1	1
CO4	U24ME508.4	2	1	1	1	-	1	1	1	1	-	1	1	1
U24ME508		2	1	1	1	-	1	1	1	1	-	1	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	analyse the thermal conductivity of the metal rod, composite walls & convective heat transfer coefficient of vertical surface, and emissivity of grey body	SDG7	Affordable and Clean Energy	Understanding heat transfer properties supports energy-efficient thermal system design, insulation improvement, and sustainable energy utilization.
CO2	calculate the efficiency and effectiveness of pin fin and heat exchangers	SDG9	Industry, Innovation and Infrastructure	Enhances industrial thermal performance through efficient heat exchanger design and engineering innovation.
CO3	determine the COP of the vapor compression, vortex tube refrigeration system, and window air conditioning system	SDG11	Sustainable Cities and Communities	Supports sustainable cooling and HVAC technologies essential for energy-efficient buildings and urban infrastructure.
CO4	evaluate the performance parameters of solar water and air heating systems	SDG13	Climate Action	Solar heating technologies promote renewable energy use and reduce environmental impact through lower carbon emissions.

AIML APPLICATIONS LABORATORY

Class: B. Tech. V – Semester		**Branch:** ME	
Course Code:	**U24ME509**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,
(based on psychomotor skills acquired from laboratory component)

CO1: develop source code to load, preprocess, and visualize datasets, and evaluate a baseline classifier by splitting data into training and testing sets using Python libraries

CO2: implement regression and classification algorithms to build machine learning models and analyze their performance metrics

CO3: apply clustering techniques and neural network models for pattern recognition and data analysis

CO4: analyze source code for mechanical engineering domain applications by integrating data preprocessing, model training and performance evaluation

LIST OF EXPERIMENTS

Experiment-1

1. Develop a program to create and perform operations on NumPy arrays.
2. Develop a program to demonstrate array indexing and slicing.
3. Develop a program to perform mathematical operations on arrays.

Experiment-2

1. Develop a program to create and manipulate Pandas DataFrames.
2. Develop a program to handle missing values using Pandas.
3. Develop a program to perform data preprocessing (feature scaling).
4. Develop a program to split dataset into training and testing sets.

Experiment-3

1. Develop a program to plot data using Matplotlib.
2. Develop a program to plot scatter graph for regression data.
3. Develop a program to visualize classification data.

Experiment-4

1. Develop a program for implementation of simple linear regression to predict a continuous variable and plot regression line.
2. Develop a program for implement logistic regression for binary classification with performance metrics.

Experiment-5

1. Develop a program to build a Decision Tree classifier, visualize the tree, and evaluate accuracy.

2. Develop a program to implement Random Forest classifier and compare with a single Decision Tree.

Experiment-6

1. Develop a program to implement k-Nearest Neighbors (k-NN).
2. Develop a program to implement Support Vector Machine (SVM).

Experiment-7

1. Develop a program to implement Navie Bayes classifier.
2. Develop a program to implement k-means clustering on a dataset and visualize clusters.

Experiment-8

1. Develop a program to implement a simple Artificial Neural Network (ANN).
2. Develop a program to demonstrate forward propagation in neural networks.

Experiment-9

1. Develop a program to analyze performance data of a CNC Lathe Machine for condition monitoring.
2. Develop a program to predict tool wear in manufacturing systems using data analytics.

Experiment-10

1. Develop a program to analyze heat exchanger performance using Linear Regression
2. Develop a program to classify weld quality based on process parameters using Decision Tree.

Experiment-11

1. Develop a program to predict boiler tube failure in thermal power plant using k-NN algorithm based on operational parameters.
2. Develop a program to analyze surface roughness characteristics of lathe machined aluminium alloy component using k-means clustering.

Experiment-12

1. Develop a program to predict whether a gear box shaft design is safe or unsafe based on stress, load, diameter, and material properties using Support Vector Machine.
2. Develop a program to analyze diesel engine performance using Multiple Linear Regression.

Textbook:

1. Parteek Bhatia, *Machine Learning with Python*, Cambridge University Press, 2023.

Reference Book(S):

1. Aurélien Géron, *Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow*, O'Reilly Media, 3rd edition, 2022.
2. Sebastian Raschka, Vahid Mirjalili, *Python Machine Learning*, Packt Publishing, 3rd edition, 2019.

Laboratory Manual

1. *Artificial intelligence and machine learning Applications Laboratory Manual*, Department of ME, KITSW

Course Articulation Matrix (CAM):		U24ME509: ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING APPLICATIONS LABORATORY												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME509.1	2	3	2	2	3	1	1	1	1	1	1	2	2
CO2	U24ME509.2	2	3	2	2	3	1	1	1	1	1	1	2	2
CO3	U24ME509.3	2	3	2	2	3	1	1	1	1	1	1	2	2
CO4	U24ME509.4	2	3	3	2	3	1	1	1	1	1	1	2	2
U24ME509		**2**	**3**	**2**	**2**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**2**	**2**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	develop source code to load, preprocess, and visualize datasets, and evaluate a baseline classifier by splitting data into training and testing sets using Python libraries	SDG4	Quality Education	Data preprocessing, visualization, and baseline model evaluation strengthen technical learning, digital literacy, and foundational AI/ML skills in engineering education.
CO2	implement regression and classification algorithms to build machine learning models and analyze their performance metrics	SDG9	Industry, Innovation and Infrastructure	Machine learning models such as regression and classification are widely used in industrial applications, enabling innovation, automation, and intelligent decision-making systems.
CO3	apply clustering techniques and neural network models for pattern recognition and data analysis	SDG11	Sustainable Cities and Communities	Clustering and neural networks support smart city applications such as traffic management, surveillance, and urban planning through intelligent data analysis.
CO4	analyze source code for mechanical engineering domain applications by integrating data preprocessing, model training and performance evaluation	SDG9	Industry, Innovation and Infrastructure	Integrating AI/ML workflows for mechanical engineering applications promotes innovation, smart manufacturing, predictive maintenance, and advanced industrial problem-solving, strengthening sustainable industrial infrastructure.

SEMINAR			
Class: B. Tech. V – Semester		**Branch:** MEE	
Course Code:	**U24ME510**	**Credits:**	**1**
Hours/Week (L-T-P-E):	**0-0-2-2**	**CIE:**	**100%**
Total Number of Teaching Hours:	**-**	**ESE:**	**-**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : select current topics in their engineering discipline & allied areas from peer reviewed journals / technical magazines/ conference proceedings

CO2 : demonstrate the skills for performing a literature survey, identify gaps, analyze the technical content and prepare a well-documented seminar report

CO3 : create informative PPT and demonstrate communication skills through effective oral presentation showing knowledge on the subject & sensitivity towards social impact of the seminar topic

CO4 : write a "seminar paper" in scientific journal style & format from the prepared seminar report

Student has to give an independent seminar on the state-of-the-art technical topics relevant to their program of study, which would supplement and complement the program assigned to each student.

Guidelines:

1. The HoD shall constitute a Department Seminar Evaluation Committee (DSEC)
2. DSEC shall allot a faculty supervisor to each student for guiding on (i) selection of topic (ii) literature survey and work to be carried out (iii) preparing a report in proper format, and (iv)effective seminar presentation
3. There shall be only Continuous Internal Evaluation (CIE) for seminar
4. The CIE for seminar is as follows:

Assessment	Weightage
Seminar Supervisor Assessment	20%
Seminar Report	30%
SDG Alignment	10%
DSEC Assessment: Oral presentation with PPT and viva-voce	40%
Total Weightage:	**100%**

Note: It is mandatory for the student to appear for oral presentation and viva-voce to qualify for course evaluation

(h) **Seminar Topic**: The topic should be interesting and conducive to discussion. Topics may be found by looking through recent issues of peer reviewed Journals / Technical Magazines on the topics of potential interest.

(i) **Report:** Each student is required to submit a well-documented report on the chosen seminar topic as per the format specified by *DSEC.*

(j) **Anti-Plagiarism Check:** The seminar report should clear the plagiarism check as per the Anti-Plagiarism (including AI Plagiarism) policy of the institute.

(k) **Presentation:** Each student should prepare a PPT with informative slides and make an effective oral presentation before the *DSEC* as per the schedule notified by the department.

(l) The student has to register for the Seminar as a supplementary examination in the following cases:

iv) The student is absent for oral presentation and viva-voce

v) The student fails to submit the report in prescribed format

vi) The student fails to fulfill the requirements of seminar evaluation as per specified guidelines.

vii) The CoE shall send a list of students registered for supplementary to the HoD concerned

viii) The DSEC, duly constituted by the HoD, shall conduct seminar evaluation and send the award list to the CoE within the stipulated time

Course Articulation Matrix (CAM):		U24ME510: SEMINAR												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME510.1	2	2	-	2	2	1	1	-	1	-	3	1	1
CO2	U24ME510.2	2	3	1	3	2	1	1	1	2	-	3	1	1
CO3	U24ME510.3	1	1	1	1	2	2	1	2	3	1	2	1	1
CO4	U24ME510.4	1	2	1	2	2	1	2	1	3	-	2	1	1
U24EC510		1.5	2	1	2	2	1.25	1.25	1.33	2.33	1	2.5	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement (The student should be able to…)**	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	select current topics in their engineering discipline & allied areas from peer reviewed journals / technical magazines / conference proceedings	**SDG 4**	Quality Education	Identifying and studying emerging ECE technologies such as 6G communications, VLSI, IoT, Artificial Intelligence, Embedded Systems, and Signal Processing promotes self-directed learning, technical competency, and continuous knowledge acquisition.
CO2	demonstrate the skills for performing literature survey, identify gaps, analyze the technical content and prepare a well-documented seminar report	**SDG 9**	Industry, Innovation and Infrastructure	Literature review and technical analysis of advanced communication systems, semiconductor technologies, smart electronics, and intelligent networks foster innovation, research culture, and technological infrastructure development.
CO3	create informative PPT and demonstrate communication skills through effective oral presentation showing knowledge on the subject & sensitivity towards social impact of the seminar topic	**SDG 11**	Sustainable Cities and Communities	Seminar presentations on smart cities, intelligent transportation systems, IoT-enabled urban services, disaster management systems, and smart communication networks highlight the role of ECE technologies in building sustainable and connected communities.
CO4	write a "seminar paper" in scientific journal style & format from the prepared seminar report	**SDG 12**	Responsible Consumption and Production	Preparation of technical papers promotes ethical dissemination of research findings, proper citation practices, responsible use of information resources, and documentation of sustainable engineering solutions.

VI SEMESTER

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	OE	U24OE601X	Startups & Entrepreneurship Basket	2	1	-	3	3
2	PCC	U24ME602	Design of Transmission Systems	2	1	-	3	3
3	PCC	U24ME603	Machining Science	2	1	-	3	3
4	PCC	U24ME604	Dynamics of Machinery	2	1	-	3	3
5	PCC	U24ME605	Computational Fluid Dynamics	2	1	-	3	3
6	IKSC	U24IK606A	Universal Human Values-II	2	-	-	2	2
7	PCC	U24ME607	Production Engineering Laboratory	-	-	2	2	1
8	PCC	U24ME608	Computational Fluid Dynamics Laboratory	-	-	2	2	1
9	HSMC	U24MH609	Technical English	-	-	2	2	1
10	ELC	U24ME610	Mini Project	-	-	2	2	1
Total:				**12**	**5**	**8**	**25**	**21**
Additional Learning@: Maximum credits allowed for Honors/Minor				**-**	**-**	**-**	**-**	**05**
Total credits for Honors/Minor students:				**-**	**-**	**-**	**-**	**26**
Summer/ Inter-sem Bridge Courses (Approved by BoS and Dean, AA): 1 week to 10 days: 1 credit to each Bridge course under additional learning (will be printed on grade sheet)				**-**	**-**	**-**	**-**	**-**

#MULTIDISCIPLINARY OPEN ELECTIVES: Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

@List of courses for additional learning through MOOCs towards Honors/Minor in Engineering shall be prescribed by the department under Honors/ Minor Curricula

B. Tech Honors with Research:

Students opting for B. Tech Honors with Research, shall undergo a 2-Month Mandatory Research Internship-II (5 Credits) at respective department during the summer vacation after VI Semester.

Startups & Entrepreneurship Basket		
Sr. No.	**Course Code**	**Course Title**
1.	U24OE601A	Design Thinking
2.	U24OE601B	Innovative Product Design and Development
3.	U24OE601C	Entrepreneurship
4.	U24OE601D	Design Studio
5.	U24OE601E	Any other course approved by BoS Chair and Dean AA

Indian Knowledge System Courses (IKSC)		
Sr. No.	**Course Code**	**Course Title**
1.	U24IK606A	Universal Human Values-II
2.	U24IK606B	Essence of Indian Traditional Knowledge

Bridge Courses for exit:

Successful completion of two subjects (6-Credits) during 2-months internship at the institute

OR

Successful completion of two suitable skill based courses (external) to qualify for Certification

C. After Third Year:(B. Voc. in ME)

(i) The candidate should pass any two of the following additional courses (Degree Level) during the 2-Months internship at institute

Exit Option to Qualify B. Voc in ME: Any Two (02) Courses during the 2 - Months internship								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	PCC	U24ME610X	Industrial Robotics	**2**	**-**	**2**	**4**	**3**
2	PCC	U24ME611X	Computer Integrated Manufacturing	**2**	**-**	**2**	**4**	**3**
3	PCC	U24ME612X	Power Plant Engineering	**2**	**-**	**2**	**4**	**3**
4	PCC	U24ME613X	Any other course approved by BoS Chair and Dean AA	**2**	**-**	**2**	**4**	**3**

(OR)

(ii) Any two suitable skill based courses to qualify for. Voc in ME Degree.

Exit Option to Qualify B. Voc in ME: Any Two (02) Skill based Courses -:								
S. No.	**Category**	**Course Code**	**Course Title**	**L**	**T**	**P**	**E**	**C**
1	SEC	U24SE614X	Certificate Course in Design and Analysis of Mechanical Systems using NX and SIMCENTER (Offered by: Centre of excellence by Digital Manufacturing and Automation, NIT, Warangal)	**-**	**-**	**6**	**6**	**3**
2	SEC	U24SE615X	Certificate Course in CNC Programming & Machining (CITD)	**-**	**-**	**6**	**6**	**3**
3	SEC	U24SE616X	Refrigeration and Air Conditioning Technician (NSQF)	**-**	**-**	**6**	**6**	**3**
4	SEC	U24SE617X	Certificate Course in Product Design and Development (CITD)	**-**	**-**	**6**	**6**	**3**
5	SEC	U24SE618X	Any other skill based course approved by BoS Chair and Dean AA	**-**	**-**	**6**	**6**	**3**

Design Thinking			
Class: B. Tech. –VI -Semester		**Branch:** Common to All	
Course Code:	**U24OE601A**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to…

CO1 :	identify customer segments and needs, assess customer-problem fit using Jobs-to-be-Done (JTBD) and customer persona frameworks
CO2 :	analyze market opportunities and competitive dynamics, estimate business feasibility and build prototypes/MVPs for validating innovative solutions
CO3 :	develop a Lean Canvas for a start-up venture by integrating value proposition, customer segments, revenue streams, key metrics and growth strategies
CO4 :	evaluate funding and team-building strategies and develop a scalable, investment-ready venture proposal through financial planning, validation and professional pitching

UNIT-I	**9 Hrs**

Identify and Analyze Real-world Problems: The Macro Industry View, Problem Identification & Segment Assembly, Customer Identification & Needs Validation, Assess 'Jobs-To-Be-Done' (JTBD) for a Customer Segment, Develop Customer Persona, Validate Customer-Problem fit, Pivot/Refine Customer-Problem fit for feasibility, Examine Ideation Techniques

UNIT-II	**9 Hrs**

Solution Idea Generation & MVP: Opportunity & Competition Mapping, Prototype Development & Minimum Viable Product (MVP), Identify Global Competitors, Review Industry Trends and Estimate Market Size (TAM), Introduction to Financial Planning, Overview of Prototypes & MVP, Build an initial Prototype, Prototypes for Early Validation, Map your Relative Position in the Market, Estimate Opportunity Size

UNIT-III	**9 Hrs**

Market Feasibility & Business Modeling: Lean Canvas Assembly, Marketing & Go-To-Market (GTM) Strategy, Examine Revenue Models, Review and Organize Lean Canvas, Build LC for your Start-up, Build LC for your Start-up, Understand Marketing and Sales, Recommend a GTM Approach, Map a Sales Process, Building an Initial Team

UNIT-IV	**9 Hrs**

Financial Management, Team Scale & Final Pitch: Funding Pathways & Scaling Orientation, Validation & Venture Presentation/Collaboration, Deep Dive into Financial Planning, Analyse the Path to Profitability, Understand Bootstrapping & Funding Options, Finding Co-Founders and Mentors, Thinking Beyond the Prototype - Scale Opportunity & Orientation, Final Milestone - Venture Idea Feasibility Presentation

Textbook(s):

1. Chandramouli Subramanian & Thiyagarajan P, Sankaran V, Design Thinking: A Hands-on Approach, University Press (India) Pvt. Ltd., 1st Edn., 2025, Hyderabad.

Reference Book(s):

1. Andrew Pressman, Design Thinking: A Guide to Creative Problem Solving for Everyone, Routledge, Taylor & Francis Group, 7th Edn., 2019, New York.
2. George E. Dieter and Linda C. Schmidt, Engineering Design, McGraw-Hill Education, 13th Edn, 2020, New Delhi.
3. Tim Brown, Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation, HarperBusiness, 7th Edn., 2009, New York.
4. Karl T. Ulrich, Steven D. Eppinger, and Maria C. Yang, Product Design and Development, McGraw-Hill Education, 2020, New Delhi.
5. Tom Kelley and David Kelley, Creative Confidence: Unleashing the Creative Potential Within Us All, Crown Business, 2013, New York.
6. Idris Mootee, Design Thinking for Strategic Innovation, John Wiley & Sons, 1st Edn., 2013, New Jersey.

Web and Video link(s): .
https://nptel.ac.in/courses/110106124; *NPTEL Video Lecture on Design Thinking - A Primer by Prof. Ashwin Mahalingam & Prof. Bala Ramadurai, IIT Madras*.

Course Articulation Matrix (CAM):		U24OE601A - Design Thinking												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PSO 1	PSO 2
CO1	U24OE601A.1	2	2	1	1	1	1	-	1	1	-	1	1	1
CO2	U24OE601A.2	1	2	2	2	1	1	1	1	1	-	1	1	1
CO3	U24OE601A.3	1	2	3	2	2	1	1	1	1	1	1	1	1
CO4	U24OE601A.4	1	1	3	2	2	2	1	2	2	2	2	1	1
U24OE601A		1.25	1.75	2.25	1.75	1.5	1.25	1	1.25	1.25	1.5	1.25	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	identify customer segments and needs, assess customer-problem fit using Jobs-to-be-Done (JTBD) and customer persona frameworks	**SDG 4**	**Quality Education**	Promotes creative learning, problem-solving, and innovation skills among students.
		SDG 9	**Industry, Innovation and Infrastructure**	Encourages innovative thinking for solving engineering and societal challenges.
CO2	analyze market opportunities and competitive dynamics, estimate business feasibility and build prototypes/MVPs for validating innovative solutions	**SDG 3**	**Good Health and Well-being**	Human-centered design improves usability, safety, and user well-being.
		SDG 11	**Sustainable Cities and Communities**	Supports identification of sustainable and community-oriented solutions.
CO3	develop a Lean Canvas for a start-up venture by integrating value proposition, customer segments, revenue streams, key metrics and growth strategies	**SDG 9**	**Industry, Innovation and Infrastructure**	Promotes innovation, product development, and technological advancement.
		SDG 12	**Responsible Consumption and Production**	Encourages efficient resource utilization and sustainable product development.
CO4	evaluate funding and team-building strategies and develop a scalable, investment-ready venture proposal through financial planning, validation and professional pitching	**SDG 8**	**Decent Work and Economic Growth**	Supports entrepreneurship, innovation-driven business models, and employability skills.
		SDG 9	**Industry, Innovation and Infrastructure**	Encourages development of practical and scalable engineering solutions.
		SDG 17	**Partnerships for the Goals**	Promotes teamwork, interdisciplinary collaboration, and stakeholder interaction.

Innovative Product Design & Development

Class: B. Tech. –VI -Semester		**Branch:** Common to All	
Course Code:	**U24OE601B**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to…

CO1 :create the systematic lifecycle of engineering design from customer requirements to technical specifications

CO2 :choose principles of industrial design, materials science, and ergonomics to optimize product usability

CO3 :implement the advanced rapid prototyping tools to compress the product development cycle

CO4 :design and build prototype performance using structural validation, risk analysis, and engineering metrics

UNIT-I	**9 Hrs**

Introduction to product design engineering: Translating user needs into Product Design Specifications (PDS); Quality Function Deployment (QFD) and the House of Quality framework; Functional decomposition and physical architecture mapping; Regulatory compliance, standards, and safety considerations in product architecture.

UNIT-II	**9 Hrs**

Principles of Industrial Design (ID): Human-centered design and Ergonomics (Anthropometry); Visual hierarchy, form generation, and product aesthetics; Material selection frameworks (structural, thermal, electrical properties) and manufacturing process mapping (DFM/DFA: Design for Manufacturing and Assembly); Design semantics and user-interface touchpoints.

UNIT-III	**9 Hrs**

Prototyping strategies: proof-of-concept vs. alpha/beta prototypes: Additive manufacturing (3D Printing: FDM, SLA, SLS) and subtractive techniques (CNC machining); Rapid tooling, silicone molding, and vacuum forming; Digital prototyping: Computer-Aided Design (CAD) modeling, assembly verification, and finite element simulations; Virtual and Augmented Reality (VR/AR) workflows for product spatial validation.

UNIT-IV	**9 Hrs**

Design of Experiments (DoE) for physical/digital prototypes: Robust design testing and failure analysis; Cost modeling, Bill of Materials (BOM) management, and engineering change orders (ECO); Sustainable engineering: Design for Environment (DFE) and lifecycle evaluation; Preparing the product blueprint for production scaling and supply chain onboarding.

Textbook(s):

1. Karl T. Ulrich and Steven D. Eppinger, Product Design and Development, Tata McGraw-Hill, 10th Edn, 2012, New Delhi.

Reference Book(S):

1. Devdas Shetty, Product Design for Engineers, Cengage Learning, 9th Edn, 2015, Boston.
2. A.K. Chitale and R.C. Gupta, Product Design and Manufacturing, PHI Learning, 2013, 13th Edn, New Delhi.
3. Kevin Otto and Kristin Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Pearson Education, 2001, New Delhi.
4. Benjamin W. Niebel and Alan B. Draper, Product Design & Process Engineering, McGraw-Hill, 1974, New York.

5. Paul Trott, Innovation Management and New Product Development, Pearson Education, 2016, Harlow.

Web and Video link(s): .

https://nptel.ac.in/courses/112107217; *NPTEL Video Lecture on Product Design and Development by Prof. Inderdeep Singh, Professor of Mechanical and Industrial Engineering, IIT Roorkee*.

Course Articulation Matrix (CAM):		**U24OE601B - Innovative Product Design & Development**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PSO 1**	**PSO 2**
CO1	**U24OE601B.1**	2	2	1	1	1	1	-	1	1	-	1	1	1
CO2	**U24OE601B.2**	1	2	2	2	1	1	1	1	1	-	1	1	1
CO3	**U24OE601B.3**	1	2	3	2	2	1	1	1	1	1	1	1	1
CO4	**U24OE601B.4**	1	1	3	2	2	2	1	2	2	2	2	1	1
U24OE601B		1.25	1.75	2.25	1.75	1.5	1.25	1	1.25	1.25	1.5	1.25	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

Course Outcome and SDG Goal Mapping:

CO–SDG Alignment Matrix				
CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	create the systematic lifecycle of engineering design from customer requirements to technical specifications	SDG 4	Quality Education	Promotes creative learning, problem-solving, and innovation skills among students.
		SDG 9	Industry, Innovation and Infrastructure	Encourages innovative thinking for solving engineering and societal challenges.
CO2	choose principles of industrial design, materials science, and ergonomics to optimize product usability	SDG 3	Good Health and Well-being	Human-centered design improves usability, safety, and user well-being.
		SDG 11	Sustainable Cities and Communities	Supports identification of sustainable and community-oriented solutions.
CO3	implement the advanced rapid prototyping tools to compress the product development cycle	SDG 9	Industry, Innovation and Infrastructure	Promotes innovation, product development, and technological advancement.
		SDG 12	Responsible Consumption and Production	Encourages efficient resource utilization and sustainable product development.
CO4	design and build prototype performance using structural validation, risk analysis, and engineering metrics	SDG 8	Decent Work and Economic Growth	Supports entrepreneurship, innovation-driven business models, and employability skills.
		SDG 9	Industry, Innovation and Infrastructure	Encourages development of practical and scalable engineering solutions.
		SDG 17	Partnerships for the Goals	Promotes teamwork, interdisciplinary collaboration, and stakeholder interaction.

Entrepreneurship

Class: B. Tech. –VI -Semester		**Branch:** Common to All	
Course Code:	**U24OE601C**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to…

CO1 :	develop an entrepreneurial mindset and create scalable business concepts through the analysis of opportunities and evaluation of business feasibility
CO2 :	analyze and validate customer needs, market demands, and pain points using structured customer discovery techniques
CO3 :	create students with practical knowledge of business modeling, unit economics, and venture monetization
CO4 :	build a clear roadmap for executing, legally safeguarding, and pitching a new venture

UNIT-I	**9 Hrs**

Introduction to Entrepreneurship: definitions, characteristics, and the evolution of an entrepreneurial ecosystem; Myths vs. Realities of starting up; Types of entrepreneurship (Social, Tech, Lifestyle, and Corporate);

Developing an entrepreneurial mindset: risk-taking, resilience, self-efficacy, and dealing with failure; Identifying personal strengths and alignment with venture archetypes.

UNIT-II	**9 Hrs**

Deep-dive Problem Identification: moving from generic ideas to systemic problems; Root-cause analysis, stakeholder mapping, and ecosystem friction points;

Customer Discovery methodology: conducting ethnographic interviews, building user personas, and mapping customer archetypes; Validating market pain points vs. "nice-to-have" solutions; Value Proposition Canvas framework.

UNIT-III	**9 Hrs**

Designing the business architecture: Introduction to the Lean Canvas and Business Model Canvas (BMC); Revenue streams, pricing strategies, and cost structures;

Fundamentals of Unit Economics: Customer Acquisition Cost (CAC), Lifetime Value (LTV), and break-even analysis; Competitor analysis and establishing a Sustainable Competitive Advantage (Moat); Basics of bootstrapping vs. external funding.

UNIT-IV	**9 Hrs**

Building the Go-To-Market (GTM) strategy: marketing channels, sales funnels, and early user acquisition; Basics of business registration, legal structures (LLP, Pvt Ltd), and intellectual property (IP) awareness; Building an early founding team, equity splitting models, and culture; Final capstone venture pitch preparation: structuring an investor pitch deck.

Textbook(s):

1. Robert D. Hisrich, Michael P. Peters, and Dean A. Shepherd, Entrepreneurship, McGraw-Hill Education, 1st Edn, 2020, New Delhi.

Reference Book(S):

1. Poornima M. Charantimath, Entrepreneurship Development and Small Business Enterprises, Pearson Education, 5th Edn, 2018, New Delhi.
2. Bruce R. Barringer and R. Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, Pearson, 4th Edn, 2019, New Delhi.
3. Eric Ries, The Lean Startup: How Today's Entrepreneurs Use Continuous Innovation, Crown Business, 2011, New York.

4. S. S. Khanka, Entrepreneurship Development, S. Chand & Company, 2010, New Delhi.
5. Peter Thiel, Zero to One: Notes on Startups, or How to Build the Future, Crown Business, 2014, New York.

Web and Video link(s): .

https://nptel.ac.in/courses/110105067; *NPTEL Video Lecture on Entrepreneurship Essentials by Prof. Rajeev Roy, Entrepreneurship Development Cell, IIT Kharagpur*.

Course Articulation Matrix (CAM):		**U24OE601C - Entrepreneurship**												
CO		**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO9**	**PO 10**	**PO 11**	**PS O1**	**PSO 2**
CO1	**U24OE601C.1**	2	2	1	1	1	1	-	1	1	-	1	-	-
CO2	**U24OE601C.2**	1	2	2	2	1	1	1	1	1	-	1	-	-
CO3	**U24OE601C.3**	1	2	3	2	2	1	1	1	1	1	1	-	-
CO4	**U24OE601C.4**	1	1	3	2	2	2	1	2	2	2	2	-	-
U24OE601C		1.25	1.75	2.25	1.75	1.5	1.25	1	1.25	1.25	1.5	1.25	-	-
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	develop an entrepreneurial mindset and create scalable business concepts through the analysis of opportunities and evaluation of business feasibility	**SDG 4**	**Quality Education**	Enhances entrepreneurial learning by fostering creativity, critical thinking, and practical problem-solving skills.
		SDG 9	**Industry, Innovation and Infrastructure**	Promotes innovation and entrepreneurship by encouraging the development of scalable ventures that contribute to industrial and technological growth.
CO2	analyze and validate customer needs, market demands, and pain points using structured customer discovery techniques	**SDG 3**	**Good Health and Well-being**	Facilitates the identification and validation of healthcare-related needs, leading to more user-centric and impactful well-being solutions.
		SDG 11	**Sustainable Cities and Communities**	Supports the development of community-focused innovations by understanding urban challenges and designing solutions aligned with citizens' needs
CO3	create students with practical knowledge of business modeling, unit economics, and venture monetization	**SDG 9**	**Industry, Innovation and Infrastructure**	Strengthens innovation ecosystems by enabling the commercialization and scaling of technology-driven ventures.
		SDG 12	**Responsible Consumption and Production**	Encourages sustainable business practices by integrating resource efficiency, value creation, and responsible production principles into venture planning
CO4	build a clear roadmap for executing, legally safeguarding, and pitching a new venture	**SDG 8**	**Decent Work and Economic Growth**	Promotes entrepreneurship and job creation by enabling the successful launch and growth of innovative ventures.
		SDG 9	**Industry, Innovation and Infrastructure**	Supports innovation-driven enterprises by facilitating the protection, development, and scaling of new technologies and business models
		SDG 17	**Partnerships for the Goals**	Encourages collaboration with investors, industry partners, mentors, and institutions to strengthen venture growth and impact.

Design Studio

Class: B. Tech. –VI -Semester		**Branch:** Common to All	
Course Code:	**U24OE601D**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to…

CO1 :	deconstruct ambiguous real-world problems into rigorous R&D challenges using patent search and prior-art techniques.
CO2 :	apply system-level architecture and feasibility models to design technical solutions.
CO3 :	build and synthesize functional high-fidelity prototypes / MVPs leveraging modern engineering tools.
CO4 :	validate engineering assumptions via stakeholder co-creation and design an institutional go-to-market plan.

UNIT-I	**9 Hrs**

Foundations of R&D-led entrepreneurship; Identifying deep-tech and high-impact industry problems; Advanced root-cause analysis; Literature review, patent landscaping, and prior art search; Defining the innovation thesis and scientific/technological core; Drafting the initial Product Design Brief.

UNIT-II	**9 Hrs**

Translating insights into technical concepts; Systematic brainstorming and TRIZ (Theory of Inventive Problem Solving) basics; Technology readiness level (TRL) mapping; Engineering/architectural design and system topology; Value proposition design and business-technical feasibility modeling; The "Napkin Pitch" for technical solutions.

UNIT-III	**9 Hrs**

Rapid prototyping paradigms (Software/Hardware/Service); Formulating the Minimum Viable Product (MVP) core feature matrix; Materials selection and Agile development sprints; UI/UX wireframing or hardware schematics; Functional architecture implementation; Risk assessment and failure mode effects analysis (FMEA).

UNIT-IV	**9 Hrs**

Surface key engineering and market assumptions; Empirical testing protocols, simulation, and data collection; Customer co-creation loops and iterative engineering; Feedback analysis from key industry stakeholders; Creating the product "On-Ramp" strategy (Go-To-Market roadmap, Pilot launch framework, and IP Protection).

Textbook(s):

1. Brian Sullivan, The Design Studio Method: Creative Problem Solving with UX Sketching, Routledge, 2015, New York.

Reference Book(S):

1. Elizabeth Boling, James Benedict Brown, Colin M. Gray, and Derek Jones, Studio Properties: A Field Guide to Design Education, Yale Press, 2021, New Haven.
2. Charles Eastman, W. Michael McCracken, and Wendy Newstetter, Design Knowing and Learning: Cognition in Design Education, Elsevier, 2001, Oxford.
3. Donald A. Schön, Educating the Reflective Practitioner: Toward a New Design for Teaching and Learning in the Professions, Jossey-Bass, 17th Edn, 1987, San Francisco.
4. Jerzy Wojtowicz, Virtual Design Studio, Hong Kong University Press, 8th Edn, 1995, Hong Kong.
5. Lois Hetland and Ellen Winner, Studio Thinking: The Real Benefits of Visual Arts Education, Teachers College Press, 12th Edn, 2007, New York.

Web and Video link(s): .

https://nptel.ac.in/courses/124105003; *NPTEL Video Lecture on Understanding Design by Prof. Prasad Onkar, Department of Design, IIT Hyderabad.*

Course Articulation Matrix (CAM):		U24OE601D - Design Studio											
CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	U24OE601D.1	2	2	1	1	1	1	-	1	1	-	1	1	1
CO2	U24OE601D.2	1	2	2	2	1	1	1	1	1	-	1	1	1
CO3	U24OE601D.3	1	2	3	2	2	1	1	1	1	1	1	1	1
CO4	U24OE601D.4	1	1	3	2	2	2	1	2	2	2	2	1	1
U24OE601D		1.25	1.75	2.25	1.75	1.5	1.25	1	1.25	1.25	1.5	1.25	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**Course Outcome**	**Mapped SDGs**		**Justification**
CO1	deconstruct ambiguous real-world problems into rigorous R&D challenges using patent search and prior-art techniques.	**SDG 4**	**Quality Education**	Promotes experiential and innovation-based learning by equipping learners with problem-solving, research, and intellectual property skills essential for the 21st century
		SDG 9	**Industry, Innovation and Infrastructure**	Fosters innovation capacity by encouraging the development of novel technologies, strengthening industry-oriented research, and supporting sustainable technological advancement.
CO2	apply system-level architecture and feasibility models to design technical solutions.	**SDG 3**	**Good Health and Well-being**	Supports the design of reliable healthcare technologies and systems that enhance accessibility, efficiency, and overall well-being
		SDG 11	**Sustainable Cities and Communities**	Facilitates the creation of smart, resilient, and resource-efficient infrastructure solutions that improve urban sustainability and quality of life.
CO3	build and synthesize functional high-fidelity prototypes / MVPs leveraging modern engineering tools.	**SDG 9**	**Industry, Innovation and Infrastructure**	Promotes technological innovation and strengthens engineering capabilities by accelerating product development and industry-relevant solutions.
		SDG 12	**Responsible Consumption and Production**	Encourages efficient resource utilization, iterative design, and sustainable product development practices that minimize waste and optimize production processes.
CO4	validate engineering assumptions via stakeholder co-creation and design an institutional go-to-market plan.	**SDG 8**	**Decent Work and Economic Growth**	Supports entrepreneurship, innovation-driven employment, and sustainable economic growth through market-oriented solution development.
		SDG 9	**Industry, Innovation and Infrastructure**	Strengthens industry-academia innovation ecosystems by facilitating the translation of validated technologies into scalable solutions.
		SDG 17	**Partnerships for the Goals**	Encourages collaboration among academia, industry, government, and end users to co-create impactful and sustainable innovations.

DESIGN OF TRANSMISSION SYSTEMS

Class: B. Tech. VI– Semester		**Branch: ME**	
Course Code:	**U24ME602**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from the theory component)

CO1: analyze the suitable flywheels and springs for engineering applications.

CO2: design belt drives and gear systems for different power transmission applications.

CO3: select and justify suitable bearings for the given loading and operating conditions.

CO4: design clutches and braking systems for different mechanical applications.

UNIT-I	**9 Hrs**

Flywheels: Principle of flywheel, Design of flywheel rim, Stresses in flywheel rim, Design of hub, arms and Pulley design.

Springs: Closed coiled helical springs subjected to axial loading, deflection and stresses in helical springs; springs under variable loads.

UNIT-II	**9 Hrs**

Belts: Classification, Geometrical relationship for the length and tensions of open and crossed flat belt drives, Design of flat belt drives and V-belt drives.

Gears: Design of spur, helical gears, Lewis's strength equation, Buckingham dynamic load equation, Wear Strength equation; Design of gear wheels.

UNIT-III	**9 Hrs**

Sliding Contact Bearings: Hydrodynamic and Hydrostatic lubrication; friction circle; Bearing Characteristic number; McKee's equation, Somerfield number, torque and power losses in journal bearings and design of journal and thrust bearings.

Rolling Element Bearings: Types of rolling element bearings, basic dynamic load rating, nominal life, average life, basic static load rating, combined radial and thrust loads, equivalent load and selection of bearings.

UNIT-IV	**9 Hrs**

Clutches: Torque Transmitting Capacity; design of Multi-disk Clutches and cone clutch.

Brakes: Introduction, design of block brakes, band brakes, internal expanding shoe brakes, band & block brake and disk brake

Textbook(s):

1. V.B. Bhandari, Design of Machine Elements, Tata McGraw-Hill, 4th edition, 2016, New Delhi. (Chapters 10,11,12,13,15,16,17,18 and 21)

Reference Book(S):

1. J.E.Shigley and C.R.Mischke Mechanical Engineering Design, Tata McGraw Hill 6th edition, 2014, New Delhi.
2. N.C.Pandya and C. S. Shah, Machine Design, Charotar Publishing House, 20th edition, 2015, Anand.

3. R.L.Norton, Machine Design: An Integrated Approach, Pearson Education India, 3rd edition, 2013, Noida.
4. R.S.Kurmi & Guptha, A Text Book of Machine Design, S.Chand & Co, 34th edition, 2016, New Delhi
5. P. Kannaiah, Machine Design, Scitech Publication Pvt. Ltd., 15th edition, 2009, Chennai.

Design Data Book:

1. PSG Design Data book for engineers, Kalaikathir Achagam, 3rd edition, 2014, Coimbatore.

Web and Video link(s):

https://onlinecourses.nptel.ac.in/e-learning/preview/noc24_me71; *NPTEL Video Lecture on Design of Mechanical Transmission Systems by Prof. Ramkumar P, Professor of ME, IIT Madras*

Course Articulation Matrix (CAM):		U24ME602: DESIGN OF TRANSMISSION SYSTEMS												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME602.1	2	2	2	2	-	-	-	-	1	1	1	2	2
CO2	U24ME602.2	2	2	2	2	-	-	-	-	1	1	1	2	2
CO3	U24ME602.3	2	2	2	2	-	-	-	-	1	1	1	2	2
CO4	U24ME602.4	2	2	2	2	-	-	-	-	1	1	1	2	2
U24ME602		2	2	2	2	-		-	-	1	1	1	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Determine the suitable types, shapes, and sizes of flywheels and springs for various engineering applications.	SDG9	Industry, Innovation and Infrastructure	Proper design of flywheels and springs improves the efficiency, reliability, and performance of industrial machinery and mechanical systems used in modern industries.
CO2	Design belt drives and gear systems for different power transmission applications.	SDG9	Industry, Innovation and Infrastructure	Efficient belt and gear drive systems support industrial automation, power transmission, and sustainable manufacturing processes in modern engineering applications.
CO3	Select and justify suitable bearings for given loading and operating conditions	SDG12	Responsible Consumption and Production	Appropriate bearing selection reduces friction, wear, energy loss, and maintenance requirements, thereby improving machine life and supporting sustainable industrial production.
CO4	Design clutches and braking systems for different mechanical applications.	SDG11	Sustainable Cities and Communities	Efficient clutch and braking systems enhance vehicle safety, reliability, and transportation efficiency, contributing to safer and more sustainable mobility systems.

MACHINING SCIENCE

Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	**U24ME603**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: *categorize tool materials, draw tool geometry in various reference systems and interpret chip formation process*

CO2: *analyze Merchant's circle and measure various cutting forces and temperature*

CO3: *determine tool wear, tool life, machinability and optimum cutting speed for maximum production rate and minimum cost criteria*

CO4: *distinguish principles and applications of various modern machining processes*

UNIT-I	**9 Hrs**

Tool Materials: Types, properties and applications.

Tool Geometry: Geometry of single point cutting tool; Geometry of multi point cutting tools - plain milling cutter and twist drill; Types of reference system – ASA, ORS & NRS and their relationships.

Mechanism of Chip Formation: Orthogonal and Oblique cutting; Chip formation - types of chips; factors affecting the chip formation; Chip geometry - shear plane model, determination of shear angle, strain and strain rate; velocity relationships.

UNIT-II	**9 Hrs**

Mechanics of Metal Cutting: Forces in chip formation; Merchant's analysis of metal cutting processes – various forces, power and specific energy; Ernst and Merchant analysis, theory of Lee and Shaffer

Measurement of Cutting Forces and Temperature: Dynamometer-principle and construction of two component lathe tool dynamometer; Source of heat in metal cutting - temperature zones, estimation of average cutting temperature, measurement of cutting temperature - tool work thermocouple.

UNIT-III	**9 Hrs**

Tool Wear and Tool Life: Types of tool Wear; Mechanisms of tool wear; Tool life – tool life criteria, relation between cutting speed and tool life; variables effecting tool life.

Machinability: Criterion for machinability; variables effecting machinability.

Economics of Machining: Types of costs; determination of optimum cutting speed for maximum production rate and minimum cost criteria.

Cutting Fluids: Types, effects, eco-friendly lubricants and sustainable applications.

UNIT-IV	**9 Hrs**

Modern Machining Processes: Classification; principle and application of Ultra Sonic Machining, Abrasive Jet Machining, Electric Discharge Machining, Electro Chemical Machining, Electron Beam Machining, Laser Beam Machining and Plasma Arc Machining, Sustainability in machining.

Textbook(s):

[1] G. K. Lal, *Introduction to Machining Science*, 3rd ed. New Delhi: New Age International Publishers, 2007. *(Chapters 2 to 8)*

[2] P. C. Sharma, A *Text Book Production Engineering*, 8th revised ed. New Delhi: S Chand & Company, 2009. *(Chapters 6, 7 and 9)*

Reference Book(S):

[1] A. Bhattacharya, *Metal Cutting Theory and Practice*, Calcutta: Central Book Publishers, 1984.

[2] Amitabha Ghosh and A K Mallik, *Manufacturing Science*, 2nd ed. New Delhi: Associated East West Press Pvt. Ltd., 2010.
[3] Geoffrey Boothroyd and Winston A. Knight, *Fundamentals of Machining & Machine Tools*, 3rd ed. New York: CRC press, 2005.
[4] V K Jain, *Advanced Machining Processes*, Mumbai: Allied Publishers, 2010.

Web and Video link(s):
https://nptel.ac.in/courses/112104290 *NPTEL Video Lecture on Machining Science by Prof. Sounak Kumar Choudhury, Professor of Mechanical Engineering, IIT Kanpur.*

Course Articulation Matrix (CAM): U24ME603 MACHINING SCIENCE														
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME603.1	2	2	-	-	-	1	-	-	1	-	1	2	1
CO2	U24ME603.2	2	2	2	-	-	1	-	-	1	-	1	2	1
CO3	U24ME603.3	2	2	2	-	-	1	-	-	1	-	1	2	1
CO4	U24ME603.4	2	2	-	-	-	1	-	-	1	-	1	2	1
U24ME603		**2**	**2**	**2**	**-**	**-**	**1**	**-**	**-**	**1**	**-**	**1**	**2**	**1**

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	*categorize tool materials, draw tool geometry in various reference systems and interpret chip formation process*	SDG 9	Industry, Innovation and Infrastructure;	Knowledge of tool materials and geometry is fundamental to industrial upgrading. Understanding the "how" behind chip formation allows for the design of more resilient and innovative tooling systems that enhance industrial capabilities.
		SDG 12	Responsible Consumption and Production	Proper tool geometry and material selection ensure "right-first-time" manufacturing. This reduces the material footprint by preventing defective parts (scrap) and ensuring raw materials are used efficiently during the cutting process
CO2	*analyze Merchant's circle and measure various cutting forces and temperature*	SDG 9	Industry, Innovation and Infrastructure;	Analyzing forces and temperatures is essential for technological research. By quantifying these variables, engineers can develop processes that require less power, contributing to more sustainable and energy-efficient industrial infrastructure.
		SDG 12	Responsible Consumption and Production	Excessive temperature leads to rapid tool degradation and thermal damage to workpieces. Justifying this CO under SDG 12 focuses on reducing chemical/material waste by controlling the thermal environment to prevent premature tool disposal and lubricant overuse.
CO3	*determine tool wear, tool life, machinability and optimum cutting speed for*	SDG 9	Industry, Innovation and Infrastructure;	Determining machinability and optimum speeds is the cornerstone of industrial productivity. It allows

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
	maximum production rate and minimum cost criteria	SDG 12	Responsible Consumption and Production	factories to operate at peak efficiency, fostering a more competitive and technologically advanced manufacturing sector. Optimizing for maximum production rate & minimum cost directly results in efficient use of natural resources. By maximizing tool life, the consumption of high-value alloys used in cutting tools is significantly reduced.
CO4	*distinguish principles and applications of various modern machining processes.*	SDG 8 SDG 9	Decent Work and Economic Growth Industry, Innovation and Infrastructure	Modern processes often allow for higher precision and the creation of complex parts required in medical and aerospace sectors. This supports economic productivity by shifting the economy toward high-value-added, technologically sophisticated manufacturing. Modern machining represents the pinnacle of manufacturing innovation. Teaching these principles prepares the workforce to build and maintain high-tech industries that can handle advanced materials that traditional methods cannot.

DYNAMICS OF MACHINERY			
Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	**U24ME604**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : apply *the effect of gyroscopic couple on the stability of different vehicles and analyze inertia forces of the slider crank mechanism & flywheel*

CO2 : *formulate the equilibrium speed for different types of centrifugal governors and distinguish their characteristics*

CO3 : *analyze static & dynamic balance of rotary & reciprocating masses*

CO4 : *evaluate natural frequency of vibration in single-degree-of-freedom systems*

UNIT-I	**9 Hrs**

Static and Dynamic Force Analysis in Mechanisms: Approximate analytical method for velocity and acceleration of the piston, angular velocity and acceleration of the connecting rod; engine force analysis-piston effort, crank effort, turning moment on crank shaft, inertia forces in reciprocating engines; Turning moment diagrams, fluctuation of speed and energy- principle of flywheel

Gyroscope: Gyroscopic couple, gyroscopic effect-aeroplanes, ships; stability of two and four-wheel vehicles

UNIT-II	**9 Hrs**

Governors: Types -Watt, Porter, Proell, Hartnell, Wilson-Hartnell governor; sensitiveness, hunting, isochronism, stability, effort and power of a governor, controlling force, coefficient of insensitiveness

UNIT-III	**9 Hrs**

Balancing: static and dynamic balancing, transfer of force to a reference plane, balancing of rotating masses in several planes; balancing of reciprocating mass -partial balancing of reciprocating mass, balancing of multi-cylinder inline engines, analysis of primary and secondary forces and couples, balancing of radial engines by direct crank and reverse crank method; working principle of balancing machine**s.**

UNIT-IV	**9 Hrs**

Vibrations: Free longitudinal vibrations, damped vibrations, logarithmic decrement; forced damped vibration of spring mass system, magnification factor, vibration isolation and transmissibility; transverse vibrations of shafts- point load, UDL and several point loads- Dunkerley's method and energy method; whirling of shafts; torsional vibrations of rotating shafts-two rotor system.

Textbook(s):

1. S. S. Rattan, *Theory of Machines, 5th ed., Tata McGraw-Hill, 2019, New Delhi. (Chapters 12, 13,14,16,17 and 18)*

Reference Book(S):

1. Amitabha Ghosh and Ashok Kumar Mallik, *Theory of Mechanisms and Machines*, East West Press Pvt. Ltd, 3rd edition, 2006, New Delhi.

2. J. E. Shigley and John Joseph Uicker, *Theory of Machines and Mechanisms*, McGraw-Hill International Edition, 2nd edition, 2003, New Delhi.
3. A. G. Ambekar, *Theory of Mechanisms and Machines,* Jain Brothers, 2009, New Delhi.
4. Thomas Bevan, *Theory of Machines,* Pearson-India, 3rd edition, 2009, New Delhi.
5. R. S. Khurmi and J. K. Guptha, *Theory of Machines*, S. Chand & Co., 14th edition, 2016, New Delhi.
6. J. S. Rao and R. V. Dukkipati, *Mechanisms and Machine Theory,* New Age International, 2nd edition, 1992, New Delhi.

Web and Video link(s):

nptel.ac.in/courses/112104114?utm_source; *NPTEL Video Lecture on Design of Dynamics of Machines by Prof. Amitabha Ghosh P, Professor of ME, IIT Kanpur*

Course Articulation Matrix (CAM):		**U24ME604: DYNAMICS OF MACHINERY**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME604.1**	2	2	2	1	-	-	-	-	1	-	1	2	1
CO2	**U24ME604.2**	2	2	2	1	-	-	-	-	1	-	1	2	1
CO3	**U24ME604.3**	2	2	2	1	-	-	-	-	1	-	1	2	1
CO4	**U24ME604.4**	2	2	2	1	-	-	-	-	1	-	1	2	1
U24 ME 604		2	2	2	1	-	-	-	-	1	-	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	apply *the effect of gyroscopic couple on stability of different vehicles and analyze inertia forces of slider crank mechanism & flywheel*	SDG 9	Build resilient infrastructure, promote sustainable industrialization and foster innovation.	The study of gyroscopic effects, flywheels, and inertia balancing contributes to efficient machine design, improved vehicle stability, reduced mechanical failures, and innovation in transportation and industrial systems. These concepts support advanced mechanical engineering solutions and sustainable industrial development.
CO2	*formulate the equilibrium speed for different types of centrifugal governors and distinguish their characteristics*	SDG 7	Ensure access to affordable, reliable, sustainable and modern energy for all	Proper governor operation improves engine speed regulation and fuel efficiency in power generation and mechanical systems. Efficient speed control minimizes energy losses and enhances sustainable utilization of energy resources
CO3	*analyze static & dynamic balance of rotary & reciprocating masses*	SDG 12	Ensure sustainable consumption and production patterns.	Dynamic balancing reduces energy losses, material fatigue, excessive wear, and maintenance requirements. This improves machine life and promotes efficient use of resources in industrial production systems
CO4	*evaluate natural frequency of vibration in single degree freedom systems*	SDG 11	Make cities and human settlements inclusive, safe, resilient, and sustainable	Vibration analysis helps improve the safety and durability of transportation systems, buildings, bridges, and public infrastructure by minimizing harmful vibrations and resonance effects.

COMPUTATIONAL FLUID DYNAMICS			
Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	**U24ME605**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from the theory component)

CO1: design simple geometries using CFD procedures and apply the Navier–Stokes equations for fluid flow analysis.

CO2 : analyse turbulence models and characteristics of partial differential equations

CO3: solve parabolic and elliptic partial differential equations

CO4: evaluate hyperbolic partial differential equations and solve simple problems using FVM

UNIT-I	9 Hrs

Introduction: History and philosophy of Computational Fluid Dynamics (CFD), CFD as a design and research tool, applications of CFD in engineering

CFD solution procedure: Creation of geometry; specification of fluid properties; specification of boundary conditions; numerical solution – initialization, solution control, convergence; post-processing.

Governing equations of fluid dynamics: Flow models, substantial derivative, physical meaning of the divergence of velocity, Navier-Stokes equations for viscous flow- continuity equation, momentum equation, energy equation; Euler equations for inviscid flow, forms of the governing equations suited for CFD, conservative form of the Navier-Stokes equations

UNIT-II	9 Hrs

Mathematical behaviour of partial differential equations: Classification of quasi-linear partial differential equations

Parabolic partial differential equations: Finite difference formulations; explicit methods - Forward Time Centered Space (FTCS), Richardson and DuFort-Frankel methods; implicit methods - Lasonen, Crank-Nicolson and Beta formulation methods, approximate factorization, fractional step methods, consistency analysis, linearization

UNIT-III	9 Hrs

Elliptic equations: Finite-difference formulation, solution algorithms, Jacobi iteration method, Gauss-Seidel iteration method, point and line-successive over-relaxation methods, and alternative direction implicit methods; Applications

Hyperbolic equations: Finite Difference Formulations, Explicit formulations- Euler's FTFS method, Euler's FTCS method, The first upwind differencing method, The Lax method, Midpoint leapfrog method, Lax-Wendroff method. Implicit Formulations- Implicit first upwind differencing method, Crank-Nicolson method, splitting methods, multi-step methods, applications to linear and nonlinear problems, Explicit First-Order Upwind Scheme, Implicit First-Order Upwind Scheme, Runge-Kutta Method.

Stability analysis: Errors; Analysis of Stability- Von Neumann stability analysis

UNIT-IV	9 Hrs

Turbulence: Definition, transition from laminar to turbulent flow, its impact on solution methodology, Characteristics of simple turbulent flows-free turbulent flows, flat plate boundary layer and pipe flow.

Turbulence models: Mixing length model, k-ε model.

Finite Volume Method (FVM): Introduction of FVM, FVM for diffusion problems - 1-D, 2-D, 3-D.

Textbook(s):

1. John, D. Anderson Jr., *Computational Fluid Dynamics*, McGraw-Hill Education, 1995. (Chapter: 1, 2, 3, 4)
2. Hoffman, K.A., and Chiang, S.T., *Computational Fluid Dynamics*, Vol. I, Engineering Education System, Kansas, USA, 2000. (Chapter: 3, 4, 5, 6)

Reference Book(s):

1. H.K. Versteeg & W. Malalasekera, *An Introduction to Computational Fluid Dynamics*, *Pearson*, 2nd edn., 2008. (Chapter: 3, 4)
2. S.V. Patankar, *Numerical Heat Transfer and Fluid Flow*, McGraw-Hill, 1st edition,1980.
3. John C. Tannehill, Dale A. Anderson, Richard H. Pletcher, Vijay Shankar, *Computational Fluid Mechanics and Heat Transfer*, Taylor & Francis, 4th edn.,2020.

Web and Video link(s):

1. *https://nptel.ac.in/courses/112103289*; *NPTEL Video Lecture on Computational Fluid Dynamics for Incompressible Flows, Prof. Amaresh Dalal, Professor of ME, IIT Guwahati*
2. *https://nptel.ac.in/courses/103106119; NPTEL Video Lecture on Computational Fluid Dynamics, Prof. Sreenivas Jayanti, Professor of ME, IIT Madras*
3. https://nptel.ac.in/courses/112105045; *NPTEL Video Lecture on Computational Fluid Dynamics, Prof. S. Chakraborty, Professor of ME, IIT Kharagpur*

Course Articulation Matrix (CAM): U24ME605 COMPUTATIONAL FLUID DYNAMICS														
CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	U24ME605.1	2	2	2	-	-	-	-	-	-	1	1	2	1
CO2	U24ME605.2	2	2	2	2	2	-	-	-	-	1	1	2	1
CO3	U24ME605.3	2	2	2	2	2	-	-	-	-	1	1	2	1
CO4	U24ME605.4	2	2	2	2	2	-	-	-	-	1	1	2	1
U24ME605		2	2	2	2	2	-	-	-	-	1	1	2	1

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	design simple geometries using CFD procedures and apply the Navier–Stokes equations for fluid flow analysis.	SDG4	Quality Education	Develops advanced computational, analytical, and engineering design skills essential for higher technical education and research.
		SDG9	Industry, Innovation and Infrastructure	Supports innovative engineering design and industrial fluid system optimization through computational modeling.
CO2	analyze turbulence models and characteristics of partial differential equations	SDG4	Quality Education	Strengthens theoretical and practical understanding of advanced fluid dynamics and numerical methods.
		SDG7	Affordable and Clean Energy	Turbulence analysis contributes to the efficient design of thermal systems, energy devices, and sustainable engineering solutions.
CO3	solve parabolic and elliptic partial differential equations	SDG9	Industry, Innovation and Infrastructure	Numerical solutions improve engineering analysis, industrial simulations, and optimized technological systems.
CO4	evaluate hyperbolic partial differential equations and solve simple problems using FVM	SDG11	Sustainable Cities and Communities	Supports sustainable infrastructure, environmental flow simulations, and efficient engineering system design.

UNIVERSAL HUMAN VALUES - II

Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	**U24IK606A**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**2-0-0-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: describe harmony within the individual by understanding the distinct roles of the self and the body

CO2 : analyze values in human relationships and apply the principles of justice, mutual happiness, and harmony in family and society.

CO3: explain the interconnectedness of nature and existence and evaluate the concept of coexistence and mutual fulfilment among all orders of nature.

CO4: apply professional ethics and sustainable practices in engineering and professional activities for societal and environmental well-being.

UNIT-I	**6 Hrs**

Course Introduction - Need, Basic guidelines, Content and Process for value education **Self-exploration**: 'Natural acceptance' and Experiential validation, Basic human aspirations, Right understanding, Relationship and Physical facility, fulfilment of aspirations, Understanding happiness and prosperity, Harmony at various levels

Understanding Harmony in the Human Being: Harmony in myself, Understanding human being, Understanding the harmony of self with the body, Harmony in self; Health; Program for self and health

UNIT-II	**6 Hrs**

Understanding Harmony in the Family: Harmony in human - human Relationship, Understanding values in human-human relationship, Meaning of Justice (universal values in relationships), Mutual happiness

Understanding Harmony in the Society: Harmony in the society, Visualizing a universal harmonious order in society- Undivided society, Universal order- from family to world family

UNIT-III	**6 Hrs**

Understanding Harmony in the Nature: Whole existence as coexistence, Understanding the harmony in the Nature, Interconnectedness and mutual fulfilment among the four orders of nature, Recyclability and Self-regulation in nature,

Understanding Harmony in the Existence: Understanding existence as co-existence of mutually interacting units in all- pervasive space; Holistic perception of harmony at all levels of existence.

UNIT-IV	**6 Hrs**

Professional Ethics: People friendly and eco-friendly production systems, Appropriate technologies and management patterns.

Case Studies: Case studies of typical holistic technologies, Management models and production systems

Textbooks:

1. R .R. Gaur, R. Sangal and G. P. Bagaria, *Human Values and Professional Ethics*, New Delhi Excel Books, 2010.

Reference Book(S):

1. A.Nagaraj, *JeevanVidya: Ek Parichaya*, Raipur: Jeevan Vidya Prakashan, Amarkantak, 2018.
2. A.N. Tripathi, *Human Values*, New Age International Publisher, 3rded., New Delhi, 2019.
3. M. Govindrajran, S. Natrajan & V.S. Senthil Kumar, *Engineering Ethics (includes Human Values)*, PHI Learning Pvt. Ltd., 12th ed., Haryana, 2011.

4. Jayshree Suresh, B. S. Raghavan, *Human Values & Professional Ethics*, 4thed., S. Chand & Co. Ltd., New Delhi, 2012.

Additional Resources:

1. A set of DVDs containing - Video of Teachers‟ Orientation Program - PPTs of Lectures and Practice Sessions (*Audio-visual material for use in the practice sessions*)

Web and Video link(s):

3. https://fdp-si.aicte-india.org/UHVII.php

Course Articulation Matrix		U24IK606A Universal Human Values - II												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24IK606A.1	2	1	-	-	-	1	-	3	-	-	-	1	1
CO2	U24IK606A.2	-	2	-	-	-	3	-	3	2	2	-	1	1
CO3	U24IK606A.3	1	2	-	-	-	2	3	2	-	-	-	1	1
CO4	U24IK606A.4	1	2	-	-	-	3	3	3	2	2	3	1	1
U24IK606B		**1**	**1.75**	-	-	-	**2.25**	**1.5**	**2.75**	**1**	**1**	**0.75**	**1**	**1**

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	describe harmony within the individual by understanding the distinct roles of the self and the body	SDG 4	Quality Education	1. Develops self-awareness, values, ethical thinking, and holistic education for responsible citizenship.
CO2	analyze values in human relationships and apply the principles of justice, mutual happiness, and harmony in family and society.	SDG 16	Peace, Justice and Strong Institutions	1. Promotes justice, mutual respect, harmonious relationships, and peaceful societies.
CO3	explain the interconnectedness of nature and existence and evaluate the concept of coexistence and mutual fulfillment among all orders of nature.	SDG 13, SDG 15	Climate Action; Life on Land	1. Enhances understanding of ecological balance, coexistence, environmental sustainability, and conservation.
CO4	apply professional ethics and sustainable practices in engineering and professional activities for societal and environmental well-being.	SDG 9, SDG 12	Industry, Innovation and Infrastructure; Responsible Consumption and Production	1. Encourages ethical professional practices, sustainable technologies, and environmentally responsible production systems.

Production Engineering Laboratory

Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	U24ME607	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on psychomotor skills acquired from laboratory component)

CO1: *develop a single point cutting tool as per ASA system using grinding and interpret the mechanism of chip formation in metal cutting*

CO2: *measure the cutting forces and tool wear, and interpret their importance in machining*

CO3: *determine the metal removal rate and surface roughness in standard EDM.*

CO4: *develop CNC part programs for turned, milled parts; ladder programming for various actuators.*

LIST OF EXPERIMENTS

1. Perform grinding of single point cutting tool as per ASA system using bench grinder.
2. Study chip formation in ferrous and non-ferrous materials.
3. Determination of shear angle in turning.
4. Determination of shear angle in shaping.
5. Measurement of cutting force in turning using lathe tool Dynamometer.
6. Measurement of tool wear in turning
7. Determination of metal removal rate of a mild steel block in electrical discharge machining (EDM).
8. Measurement of surface roughness of a component machined by EDM using surface roughness tester
9. Preparation of a part program for step turning and tapered component
10. Production of linear and circular profile cut on a component using CNC milling machine.
11. Preparation of a part program to cut alphabets on CNC milling machine
12. Control of A.C. Non servomotor clockwise and anti-clockwise with time delay

Textbook(s):

[1] G. K. Lal, "Introduction to Machining Science", *3rd ed*., New Age International Publishers, 2012.

[2] P. Radha Krishnan," Introduction to CNC Machines", New Age International, New Delhi, 1995.

Reference Book(S):

[1] ATS Manual of L.S. Mechatranics, Secunderabad, 2000.

[2] Bolton W, "Mechatronics", *5th ed.*, Pearson Education, 2010.

Laboratory Manual (for laboratory component):

1. *Production Engineering Laboratory Manual, Dept. of ME, KITSW.*

Course Articulation Matrix (CAM):		U24ME607: PRODUCTION ENGINEERING LABORATORY												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME607.1	2	2	1	1	1	1	-	1	1	-	1	2	1
CO2	U24ME607.2	2	2	1	1	1	1	-	1	1	-	1	2	1
CO3	U24ME607.3	2	2	1	1	1	1	-	1	1	-	1	2	1
CO4	U24ME607.4	2	2	1	1	1	1	-	1	1	-	1	2	1
U24ME607		**2**	**2**	**1**	**1**	**1**	1	**-**	**1**	**1**	**-**	**1**	**2**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	*prepare a single point cutting tool as per ASA system using grinding and interpret the mechanism of chip formation in metal cutting*	SDG 9	Industry, Innovation and Infrastructure	Tool grinding and understanding chip formation improve machining efficiency, precision manufacturing and industrial productivity, supporting sustainable industrial development and innovation.
CO2	*measure the cutting forces and tool wear, and interpret their importance in machining*	SDG 12	Responsible Consumption and Production	Monitoring cutting forces and tool wear helps optimize machining parameters, reduce material wastage, improve product quality and ensure efficient use of resources in manufacturing processes.
CO3	*determine the metal removal rate and surface rough ness in standard EDM*	SDG 9	Industry, Innovation and Infrastructure	Evaluating metal removal rate and surface roughness in EDM enhances process optimization, advanced manufacturing capability and technological innovation in modern production industries.
CO4	*develop CNC part programs for turned, milled parts; ladder programming for various actuators*	SDG 8	Decent Work and Economic Growth	CNC and automation programming skills promote advanced manufacturing competence, industrial automation, employability and productivity growth in modern engineering industries.

COMPUTATIONAL FLUID DYNAMICS LABORATORY

Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	**U24ME608**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: *apply fundamental principles of fluid flow and heat transfer to formulate computational models for engineering problems.*

CO2 : *develop and perform CFD simulations with ANSYS Fluent for 2D and 3D fluid-flow and thermal systems.*

CO3: *apply appropriate boundary conditions, meshing strategies and solver settings for steady-state and transient CFD simulations.*

CO4: *interpret simulation results using contour plots, streamline patterns and performance parameters to inform engineering decision-making.*

1. ANSYS Fluent Simulation of Steady-State Heat Transfer in a Two-Dimensional Slab
2. Design and Thermal Analysis of a Cylindrical Metal Rod Using ANSYS Fluent
3. Design and Thermal Analysis of a Hollow Cylindrical Metal Rod Using ANSYS Fluent
4. ANSYS Fluent Simulation of Steady-State Thermal Conduction in a Composite Wall
5. Design and Simulation of heat dissipation from a computer chip
6. Computational Analysis of Boundary Layer Flow over a Flat Plate in ANSYS Fluent
7. ANSYS Fluent Simulation of Internal Flow in a Straight Uniform Channel
8. Design and CFD Analysis of Separated Flow in Backward-Facing Step Geometry
9. Simulation of Time-Dependent Flow Past a Circular Cylinder to Study Vortex Shedding Using ANSYS Fluent
10. Aerodynamic Analysis of External Flow over a Simplified Car Model Using ANSYS Fluent
11. ANSYS Fluent Modelling of a Single Battery Cell with the Multi-Scale Multi-Domain (MSMD) Approach
12. Numerical Modelling of 2D Steady-State Heat Conduction in a Slab Using MATLAB
13. MATLAB Simulation of 1D Heat Conduction Using the Explicit Finite Difference Method

Textbook(s):

1. John, D. Anderson Jr., Computational Fluid Dynamics, McGraw-Hill Education, 1995.

Reference Book(S):

1. Hoffman, K.A., and Chiang, S.T., Computational Fluid Dynamics, Vol. I, II, and III, Engineering Education System, Kansas, USA, 2000.
2. S.V. Patankar, Numerical Heat Transfer and Fluid Flow, McGraw-Hill, 1st edition,1980.
3. John C. Tannehill, Dale A. Anderson, Richard H. Pletcher, Vijay Shankar
4. Computational Fluid Mechanics and Heat Transfer, Taylor & Francis, 4th edn.,2020.
5. H.K. Versteeg & W. Malalasekera, An Introduction to Computational Fluid Dynamics, Pearson, 2nd edn.,2008.

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc22_ee116/preview; *NPTEL Video Lecture on Computational Fluid Dynamics for Incompressible Flows, Prof. Amaresh Dalal, Professor of ME, IIT* ***Guwahati***

2. ***https://nptel.ac.in/courses/103106119;*** *NPTEL Video Lecture on Computational Fluid Dynamics, Prof. Sreenivas Jayanti, Professor of ME, IIT Madras*

Laboratory Manual (for laboratory component):

1. *Computational Fluid Dynamics Laboratory Manual,* Department of ME, KITSW

Course Articulation Matrix (CAM):		U24ME608: COMPUTATIONAL FLUID DYNAMICS LABORATORY												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME608.1	2	2	2	2	2	1	1	-	-	-	-	2	2
CO2	U24ME608.2	2	2	2	2	2	1	1	-	1	-	-	2	2
CO3	U24ME608.3	2	2	2	2	2	1	1	-	-	-	-	2	2
CO4	U24ME608.4	2	2	2	2	2	1	1	-	1	1	-	2	2
U24ME608		3	2	2	2	2	1	1	-	1	1	-	3	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix

CO	CO Statement *The student should be able to*	Relevant SDG	SDG Description	Mapping Justification
CO1	Apply fundamental principles of fluid flow and heat transfer to formulate computational models for engineering problems.	SDG4 & SDG9	Quality Education & Industry, Innovation and Infrastructure	Builds strong technical knowledge and analytical skills in sustainable engineering design, supporting advanced education and innovative industrial problem-solving.
CO2	Develop and perform CFD simulations with ANSYS Fluent for 2D and 3D fluid-flow and thermal systems.	SDG7 & SDG9	Affordable and Clean Energy & Industry, Innovation and Infrastructure	CFD simulation promotes efficient design of thermal systems, renewable energy devices and optimized industrial processes contributing to innovation and clean energy solutions.
CO3	Apply appropriate boundary conditions, meshing strategies, and solver settings for steady-state and transient CFD simulations.	SDG9 & SDG12	Industry, Innovation and Infrastructure & Responsible Consumption and Production	Accurate simulations reduce physical prototyping, material waste, and energy use while improving sustainable production and engineering efficiency.
CO4	Interpret simulation results using contour plots, streamline patterns, and performance parameters to inform engineering decision-making.	SDG11 & SDG13	Sustainable Cities and Communities & Climate Action	Data-driven design decisions help improve energy systems, environmental management, thermal comfort and sustainable infrastructure development.

Technical English

Class: B. Tech. VI– Semesters		**Branch:** Common to all Branches	
Course Code:	**U24MH609**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**100**
Total Number of Teaching Hours:	**24 Hrs**	**ESE:**	**-**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 :	develop effective listening, speaking, reading and writing skills by understanding native-speaker conversations and expressing ideas clearly and confidently using appropriate vocabulary, while maintaining fluency, coherence and accurate pronunciation.
CO2 :	enhance communication and professional writing skills through podcast comprehension, group discussions, resume and email writing
CO3 :	develop the ability to understand reading texts, conversations of both native and non-native speakers, interpret visual information, and produce clear and well-structured technical reports.
CO4 :	develop the ability to perform well in interviews and present effectively with clarity of speech and appropriate accent.

Activity-1 **2 hrs**

Phonetic Foundations, Authentic Audio-Visual Comprehension & Vocabulary Enhancement: Speech Sounds- Phonemes (Vowels and consonant sounds), word stress, syllables - their role and importance in spoken English, **Authentic Audio-Visual Comprehension**: Movie Clips - Screening of a short native-speaker clip - context comprehension, focus attention on accent features and key expressions, **Vocabulary:** Word Formation- Prefixes-Suffixes.

Activity: Practice pronunciation through Read-Record-Reflect, analyze audio-visual content for comprehension and expression usage.

Activity - 2 **2 hrs**

Story Narration, Writing Skills and Vocabulary Enhancement- Narrative structure (beginning, build-up, climax, conclusion), Cohesive devices, Voice modulation & Expression. **Writing:** Principles of Paragraph Writing- Importance of Coherence in Writing- Cause and Effect Paragraphs. **Vocabulary:** Synonyms and antonyms.

Activity: Narrate structured stories with peer interaction, Read-Record-Reflect storytelling activity for pronunciation and expression enhancement, Write a coherent cause and effect paragraph, Vocabulary practice exercises on synonyms and antonyms.

Activity - 3 **2 hrs**

Reading Comprehension, Vocabulary Enhancement & Elocution Skills- Reading Comprehension: Main idea identification, interpretation, critical analysis. **Vocabulary Enhancement**: One-word substitutes. **Elocution:** Speech delivery skills (organisation, voice modulation, fluency, pronunciation, and audience engagement).

Activity: Read and analyze passages for comprehension and critical interpretation, Read-Record-Reflect activity for improving reading fluency and pronunciation, Vocabulary exercises on one-word substitutes, and deliver a short speech with emphasis on clarity, confidence, and effective expression.

Activity-4 **2 hrs**

Think–Pair–Share Conversation (Podcast-Based), **Vocabulary Enhancement:** Introduction to authentic spoken English through podcasts, listening for gist and specific information, and note-taking. Think–Pair–Share strategy, use of linking words and expressing agreement/disagreement politely

Vocabulary Enhancement: Idioms in context and usage

Activity: Listen to podcasts for comprehension and note-making, Think–Pair–Share discussions to exchange ideas and respond confidently, Speak-Record-Reflect activity for improving speaking fluency, pronunciation, and expression

Activity -5	**2 hrs**
Group Discussion, Vocabulary Enhancement: GD format and roles, rules of participation, **Vocabulary –** Word Pairs, commonly confused words **Activity:** Engage in group discussions focusing on clear expression and interaction and word pair exercises	
Activity -6	**2 hrs**
Reading Comprehension, Visual Interpretation & Vocabulary Enhancement: Skimming and scanning, identifying main and supporting ideas, distinguishing fact and opinion. **Visual Interpretation:** Interpreting visual cues, logical sequence. **Vocabulary**: Phrasal Verbs: separable and inseparable forms, and contextual usage. **Activity:** Engage in reading comprehension tasks for critical analysis, describe pictures , Speak–Record–Reflect activity for improving fluency, pronunciation, and expression, and phrasal verbs practice exercises	
Activity -7	**2 hrs**
Motivational Speeches, Presentation Skills & Vocabulary Enhancement: identifying central theme and tone, note-taking, Narrative techniques. **Presentation –** Speak to Inspire- topic selection, structure (introduction–body–conclusion), **Vocabulary Enhancement –** Collocations- Introduction to collocations, types of collocations, and contextual usage **Activity**: Listen to motivational speeches for comprehension and analysis, deliver a 3–5-minute inspirational presentation, Speak–Record–Replay activity for improving fluency, pronunciation, and expression, and collocations practice exercises	
Activity -8	**2 hrs**
Writing & Vocabulary Enhancement: Professional Resume Writing techniques, Action verbs in resume writing, Letter of Application, E-mail Etiquette—vocabulary: Jumbled sentences **Activity**: Prepare a professional resume using an appropriate format and action verbs, write a letter of application and formal e-mail following etiquette and jumbled sentence exercises	
Activity -9	**2 hrs**
Reading Comprehension, Newspaper Reading & Vocabulary Enhancement: Intensive reading , Extensive reading, Newspaper reading:5W1H method, Summarization, vocabulary building **Activity:** Reading comprehension exercises, Summarizing news content, discussion of current events, Speak–Record–Replay activity for improving fluency, pronunciation and expression. Vocabulary building through contextual usage from news articles	
Activity -10	**2 hrs**
PowerPoint Presentations: Concept and purpose of presentations, layout and structure (title, introduction–body–conclusion), slide design elements, visual aids, common mistakes to avoid **Activity:** Design and present a poster or PowerPoint presentation on a given topic, Speak–Record–Replay activity for improving fluency, pronunciation and expression, peer interaction and feedback sessions	
Activity-11	**2 hrs**
Essay Writing, Vocabulary Enhancement – Concept and Types of Essays**,** Essay structure (introduction–body–conclusion), paragraph coherence, clarity and objectivity, Sentence completion with correct word/Group alternative word/group **Activity:** Write essays on given topics focusing on structure, coherence, and clarity. Sentence completion practice exercises	
Activity-12	**2 hrs**
Mock Interview – Technical & HR: Introduction to mock interviews: Purpose and importance, types of interviews, interview etiquette, self-introduction, common HR questions, self-assessment **Activity:** Mock interview with appropriate dress code. Record and review own performance, Feedback session	
Textbook(s): 1. Arun Sharma & Meenakshi Upadhyay, "*Verbal Ability and Reading Comprehension for CAT & Other Management Examinations*", 8th Edition, McGraw Hill Education (India) Private Ltd, Chennai, 2018	

2. Meenashki Raman & Sangeethe Sharma, *"Technical Communication: Principles and Practice,* 3rd Edition, New Delhi; New York: Oxford University Press,2004

Reference Book(S):

1. Nishit K. Sinha, "Verbal Ability and Reading Comprehension for the CAT", 3rd Edition Pearson India Education Services Pvt. Ltd., Chennai
2. Harper Collins, "Collins COBUILD English Grammar" Third Edition, Harper Collins Publishers Ltd.
3. Jerald J. Alfred, Charles T. Brusaw and Walter E. Oliu," Handbook for Technical Writing"12th Edition, Macmillan
4. R.S. Agarwal, "A modern Approach to Verbal and Non-Verbal Reasoning" Revised edition 2025 , Chand Publishing, India.

Web and Video link(s):

1. Learn/Practice English with MOVIES (Lesson #1) Title: The Incredibles https://www.youtube.com/watch?v=5SfQhkMsUFk&list=PLA7lNLNvxTzig5dqfGl8DGbLOvUI08yXg&inde x=2
2. Learn English with WRECK-IT RALPH https://www.youtube.com/watch?v=wVhG59zh4uQ&list=PLA7lNLNvxTzig5dqfGl8DGbLOvUI08yXg&ind ex=4
3. The Pursuit of Happiness (2006): Most Powerful Moments! https://www.youtube.com/watch?v=TkD1QvjKlqU
4. **Podcast by** Raul John" Inside the Mind of India's AI Kid". Business Today https://www.youtube.com/watch?v=biCrIlhZrC4
5. Podcast by Sudha Murthy - So What If I Lost the Battle, I Lived the War | The Ranveer Show https://www.youtube.com/watch?v=KwXtalUuhLc
6. Motivational Talk by Gour Gopal Das, SLEEPLESS Nights for Overnight SUCCESS https://www.youtube.com/watch?v=YyCXp_E4sMU
7. Motivational Talk by Admiral McRaven's Speech for Your Day, "5 Minutes to Start Your Day Right! - MORNING MOTIVATION" https://www.youtube.com/watch?v=b-Pn0yXL9y8

Laboratory Manual (for laboratory component):

1. Technical English Manual prepared by the faculty of English, KITSW.

Course Articulation Matrix (CAM):		**U24MH609:** Technical English												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24MH607.1**	-	-	-	-	-	-	-	-	2	-	2	-	-
CO2	**U24MH607.2**	-	-	-	-	-	-	-	2	2	-	2	-	-
CO3	**U24MH607.3**	-	-	-	-	-	-	-	-	2	-	2	-	-
CO4	**U24MH607.4**	-	-	-	-	-	-	-	2	2	-	2	-	-
U24MH607		-	-	-	-	-	-	-	2	2	-	2	-	-
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	develop effective listening, speaking, reading and writing skills by understanding native-speaker conversations and expressing ideas clearly and confidently using appropriate vocabulary,	SDG 4	Quality Education	This aligns with SDG-4 as it develops effective listening, speaking, reading and writing skills that enable learners to understand native-speakers communication and communicate clearly and fluently with appropriate vocabulary and pronunciation to promote quality education

	while maintaining fluency, coherence and accurate pronunciation.			
CO2	enhance communication and professional writing skills through podcast comprehension, group discussions, resume and Quality Education email writing	SDG 4, 8	Quality Education & Decent work and Economic growth	This aligns with SDG-4 as it promotes quality education by enhancing employability skills and professional writing skills through podcast comprehension, resume writing, critical reading and group discussion This aligns with SDG-8 as it helps students expect productive employment and decent work opportunities by fostering academic and creative thinking
CO3	develop the ability to understand reading texts, conversations of both native and non-native speakers, interpret visual information, and produce clear and well-structured technical reports	SDG 4	Quality Education	This aligns with SDG-4 as it develops the ability to interpret visual information and produce clear and well-structured technical reports for academic and professional contexts
CO4	develop the ability to present effectively with clarity of speech and appropriate accent	SDG 4	Quality Education	This aligns with SDG-4 as it enhances effective presentation skills and perform well in interviews

MINI PROJECT			
Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	U24ME610	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-1**	**CIE:**	**60%**
Total Number of Teaching Hours:	**-**	**ESE:**	**40%**

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

(based on cognitive skills acquired from theory component)

CO1: apply knowledge to practice to design & conduct experiments and utilize modern tools for developing working models / process / system leading to innovation & entrepreneurship

CO2: demonstrate the competencies to perform literature survey, identify gaps, analyze the problem and prepare a well-documented Mini project report

CO3: make an effective oral presentation through informative PPTs, showing knowledge on the subject & sensitivity towards social impact of the Mini project

CO4: write a "Mini project paper" in scientific journal style & format from the prepared Mini project report and create a video pitch on Mini project

Student has to take up independent mini project on innovative ideas, innovative solutions to common problems using their knowledge relevant to courses offered in their program of study, which would supplement and complement the program assigned to each student.

Guidelines:

1. The HoD shall constitute a *Department Mini Project Evaluation Committee (DMPEC)*
2. *DMPEC* shall allot a faculty supervisor to each student for guiding on (i) selection of topic (ii) literature survey and work to be carried out (iii) preparing a report in proper format and (iv) effective mini project oral presentation
3. There shall be only continuous Internal Evaluation (CIE) for miniproject
4. The CIE for mini project is as follows:

Assessment	Weightage
Mini Project Supervisor Assessment	15%
Working model / process / software package / system developed	20%
Mini Project report	15%
Mini Project paper	10%
Video pitch	10%
DMPEC Assessment: *Oral presentation with PPT and viva-voce*	15%
SDG Alignment	5%
Research Alignment	10%
Total Weightage:	**100%**

Note: It is mandatory for the student to appear for oral presentation and viva-voce to qualify for course evaluation

(m) **Mini Project Topic**: The topic should be interesting and conducive to discussion. Topics may be found by looking through recent issues of peer reviewed Journals / Technical Magazines on the topics of potential interest

(n) **Working Model**: Each student is requested to develop a working model / process / system on the chosen work and demonstrate before the *DMPEC* as per the dates specified by *DMPEC*

(o) **Report:** Each student is required to submit a well-documented report on the chosen seminar topic as per the format specified by *DMPEC*

(p) **Anti-Plagiarism Check:** The seminar report should clear plagiarism check as per the Anti-Plagiarism policy of the institute

(q) **Presentation:** Each student should prepare PPT with informative slides and make an effective oral presentation before the *DMPEC* as per the schedule notified by the department

(r) **Video Pitch:** Each student should create a pitch video, which is a video presentation on his / her mini project. Video pitch should be no longer than 5 minutes by keeping the pitch concise and to the point, which shall also include key points about his / her business idea / plan (*if any*) and social impact

(s) The student has to register for the Mini project as supplementary examination in the following cases:

ix) he/she is absent for oral presentation and viva-voce

x) he/she fails to submit the report in prescribed format

xi) he/she fails to fulfill the requirements of Mini project evaluation as per specified guidelines

xii) The CoE shall send a list of students registered for supplementary to the HoD concerned

xiii) The DSEC, duly constituted by the HoD, shall conduct Mini project evaluation and send the award list to the CoE within the stipulated time

Course Articulation Matrix (CAM):		**U24EC610 Mini Project**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	U24EC610.1	3	3	2	3	3	2	1	2	1	2	2	2	1
CO2	U24EC610.2	2	2	2	3	2	1	1	1	2	1	3	2	1
CO3	U24EC610.3	1	1	1	1	2	2	1	2	3	1	2	2	1
CO4	U24EC610.4	1	2	1	2	2	1	2	1	3	1	2	2	1
U24EC610		1.75	2	1.5	2.25	2.25	1.5	1.25	1.52	2.25	1.25	2.25	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement (The student should be able to…)**	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	apply knowledge to practice to design & conduct experiments and utilize modern tools for developing working models / process / system leading to innovation & entrepreneurship	**SDG 9**	Industry, Innovation and Infrastructure	Mini projects involve the design and development of innovative ECE solutions such as IoT systems, embedded systems, communication networks, VLSI applications, and intelligent electronic devices. These activities promote technological innovation, entrepreneurship, and sustainable industrial infrastructure.
CO2	demonstrate the competencies to perform literature survey, identify gaps, analyze the problem and prepare a well-documented Mini project report	**SDG 4**	Quality Education	Literature review, problem analysis, technical documentation, and independent learning enhance research skills, critical thinking, and lifelong learning capabilities, thereby supporting quality technical education and knowledge creation.

CO–SDG Alignment Matrix				
CO	**CO Statement (The student should be able to…)**	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO3	make an effective oral presentation through informative PPTs, showing knowledge on the subject & sensitivity towards social impact of the Mini project	**SDG 11**	Sustainable Cities and Communities	Presentation and discussion of ECE-based solutions for smart cities, intelligent transportation systems, environmental monitoring, public safety, healthcare technologies, and digital connectivity contribute to sustainable and inclusive community development.
CO4	write a "Mini project paper" in scientific journal style & format from the prepared Mini project report and create a video pitch on Mini project	**SDG 12**	Responsible Consumption and Production	Scientific reporting and dissemination of project outcomes promote responsible innovation, ethical publication practices, efficient utilization of resources, and sustainable technology development.

INDUSTRIAL ROBOTICS			
Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	**U24ME610X**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**50%**
Total Number of Teaching Hours:	**16 Hrs**	**ESE:**	**50%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : categorize various drives and control systems for robots

CO2 : analyze motion of manipulator using direct kinematics

CO3 : design a trajectory to robot manipulator

CO4 : analyze the sensing and vision systems of robots

UNIT-I	**4 Hrs**

Basic concepts in robotics: Classification, advantages and applications of robots; different joints in a manipulator; degrees of freedom of a manipulator for positioning and orientation. Work space- dexterous and reachable; factors affecting accuracy and repeatability of a manipulator, controller resolution.; drives and control systems for robots.

UNIT-II	**4 Hrs**

Robot arm kinematics: rotation about two distinct moving axes, rotation about three distinct moving axes, transformation matrix for rotations, combined rotations, transformation between coordinate systems,

UNIT-III	**4 Hrs**

Trajectory Planning: General considerations in trajectory planning, joint interpolated trajectories, planning of cartesian path trajectories

UNIT-IV	**4 Hrs**

Robot vision and sensing: Different types of sensors-proximity, touch, force and torque sensors; low-level, high-level vision and vision systems.

Textbook(s):

1. **Fu, K. S., Gonzalez, R. C., and Lee, C. S. G.,** *Robotics: Control, Sensing, Vision, and Intelligence*, McGraw-Hill Education, New Delhi, 2008.

Reference Book(S):

1. J Craig, '*Introduction to Robotics: Mechanics and Control*', Addison-Wesley, Reading, MA, 1989 (second edition).
2. S.K. Saha, *Introduction to robotics*, 2nd ed. New Delhi: Tata McGraw-Hill Education, 20 M. P. Groover, Industrial Robotics: Technology, Programming, and Applications, McGraw-Hill Education, 1986.
3. John J. Craig, *Introduction to Robotics: Mechanics and Control*, 3rd Ed., Pearson Education, 2004.
4. Richard D. Klafter, Thomas A. Chmielewski, and Michael Negin, *Robotic Engineering: An Integrated Approach*, Prentice Hall, 1989.
5. Bruno Siciliano and Oussama Khatib (Eds.), *Springer Handbook of Robotics*, Springer, 2008.
6. Saeed B. Niku, *Introduction to Robotics: Analysis, Control, Applications*, 2nd Ed., Wiley India, 2011.

Web and Video link(s):

http://nptel.ac.in/courses/101105662 ; NPTEL Video Lecture on Introduction to Robotics by Prof. T. Asokan, Professor, Department of Engineering Design, Indian Institute of Technology Madras

Course Articulation Matrix (CAM):		U24ME610X : INDUSTRIAL ROBOTICS												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME610X.1	2	1	1	1	-	1		-	1	-	-	2	1
CO2	U24ME610X.2	2	1	1	1	-	1		-	1	-	2	2	1
CO3	U24ME610X.3	2	1	1	1	-	1		-	1	-	2	2	1
CO4	U24ME610X.4	2	1	1	1	-	1		-	1	-	2	2	1
U24ME610		2	1	1	1	-	1		-	1	-	2	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	categorize various drives and control systems for robots	SDG9	Industry, Innovation, Infrastructure	Enables efficient automation and precision manufacturing
CO2	analyze motion of manipulator using direct kinematics	SDG9	Industry, Innovation, Infrastructure	Enables precision automation in manufacturing, boosting industrial efficiency.
CO3	design a trajectory to robot manipulator	SDG9	Industry, Innovation, Infrastructure	Enables reliable automation in manufacturing lines.
CO4	analyze the sensing and vision systems of robots	SDG11	Sustainable Cities & Communities	Improves safety in autonomous vehicles and urban robotics.

COMPUTER INTEGRATED MANUFACTURING			
Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	U24ME611X	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**16 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : Compare and contrast types of automation and solve problems on production concepts using mathematical models

CO2 : develop NC part programming and explain robot configuration.

CO3 : build system models using basic building block

CO4 : develop ladder programs and suggest a suitable controller for a given industrial application

UNIT-I	4 Hrs

Automation in Production Operations: Introduction, functions in manufacturing, types of automations,

Numerical Control of Production Systems: Basic principle and elements of NC, CNC & DNC systems.

UNIT-II	4 Hrs

NC Part programming: Introduction, manual and computer aided part programming.

CAPP: Introduction, types of process planning- retrieval and generative, applications**.**

UNIT-III	4 Hrs

Mechatronics: Introduction**,** Systems, Examples of mechatronic systems.

Basic Models: Mathematical models, mechanical system building blocks, electrical system building blocks, fluid system building blocks and thermal system building blocks.

UNIT-IV	4 Hrs

Programmable Logic controller: Basic P L C structure, Input/output processing, Logic functions.

Closed Loop Controllers: Continuous and discrete processes; Control modes - Two step mode and proportional mode;

Textbooks:

[1] Mikell P Groover, "*Automation, Production system and Computer Integrated Manufacturing*", 4th ed., Prentice Hall of India, New Delhi, 2016. (Chapters 1,2,8,9,10,11,16 and 24)

[2] Bolton W, "*Mechatronics*",*6th ed*., Pearson Education, 2015 (Chapters 1, 8,9,11 and 21)

Reference Books:

[1] PN Rao, NK Tiwari and TK Kundra, *Computer Aided Manufacturing,* Tata McGraw-Hill, New Delhi,2012.

[2] Yorem Koran, *Computer Numerical Control of Manufacturing Systems,* McGraw-Hill, New Delhi, 2004.

[3] Nitaigour Premch and Mahalik, *Mechatronics: Principles concepts and applications,* Tata McGraw-Hill, New Delhi, 2012.

[4] HMT, *Mechatronics,* Tata McGraw-Hill, New Delhi, 2017.

Web and Video link(s):

https://nptel.ac.in/courses/112104289 : NPTEL course on Computer Integrated Manufacturing by Prof. J. Ramkumar & Prof. Amandeep Singh, IIT Kanpur

Course Articulation Matrix (CAM):		U24ME611X : COMPUTER INTEGRATED MANUFACTURING												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME611X.1	2	2	-	-	-	1	-	-	1	-	-	1	2
CO2	U24ME611X.2	2	2	-	-	-	1	-	-	1	-	-	1	2
CO3	U24ME611X.3	2	2	2	2	2	1	-	-	1	-	-	1	2
CO4	U24ME611X.4	2	2	2	2	2	1	-	-	1	-	-	1	2
U24ME611X		2	2	2	2	2	1	-	-	1	-	-	1	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Compare and contrast types of automation and solve problems on production concepts using mathematical models	SDG 9	Industry, Innovation and Infrastructure; Responsible	Optimizing production via mathematical models builds resilient infrastructure and fosters industrial efficiency.
CO2	*develop NC part programming and explain robot configuration, group technology and cellular manufacturing*	SDG 9	Industry, Innovation and Infrastructure; Responsible	These are core Industry 4.0 technologies that drive innovation and modernize industrial processes.
CO3	build system models using basic building block	SDG 12	Consumption and Production	Accurate system modeling ensures **efficient resource use**, reducing waste in the manufacturing lifecycle.
CO4	develop ladder programs and suggest a suitable controller for a given industrial application	SDG 8	Decent Work and Economic Growth	Automation through PLC/controllers promotes higher economic productivity and safer work environments.

POWER PLANT ENGINEERING			
Class: B. Tech. VI – Semester		**Branch:** ME	
Course Code:	**U24ME612X**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-0-2-4**	**CIE:**	**50%**
Total Number of Teaching Hours:	**16 Hrs**	**ESE:**	**50%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,
(based on cognitive skills acquired from the theory component)

CO1: analyze the working principles of a nuclear power plant
CO2 : illustrate the working of steam power plants
CO3: interpret the working of combined cycle power plants
CO4: evaluate various economic parameters of power plants

UNIT-I	**4 Hrs**

Energy Resources: Classification, present scenario in modern power plants, types of power plants, power potentiality in India
Nuclear power plants: Indian nuclear power stations, site selection, principle of nuclear fission, fuels, components of reactor

UNIT-II	**4 Hrs**

Steam power plants: Classification, site selection, modern power plant layout and system components; fuel handling, burning-over feed and under feed stokers, pulverized fuel and its advantages

UNIT-III	**4 Hrs**

Combined cycle power plants: Topping cycle, bottoming cycle, gas and steam turbine combined cycle power plant-working principle, layout, advantages, limitations

UNIT-IV	**4 Hrs**

Power plant economics: Introduction, load curves, demand, load, diversity and plant capacity factor; elements of costs of power, fixed and operating costs, depreciation methods

Textbook(s):

1. S. C. Arora & S. Domakundwar, —A Course in Power Plant Engineering", Dhanpat Rai & Sons, 3rd ed. New Delhi: 2013.

Reference Book(s):

1. WakilM.M.El., —Power Plant Technology", McGraw-Hill, New York, 1988
2. Nag P.K., —Power Plant Engineering", Tata McGraw-Hill, New Delhi, 2002
3. Nagpal G.R., —Power Plant Engineering", Khanna Publishers, New Delhi, 1988
4. R.K Rajput - Power plant Engineering, Laxmi publication PVT Ltd, 5th edition, New Delhi, 2007

Web and Video link(s):

1. https://nptel.ac.in/courses/112103289; *NPTEL Video Lecture on Computational Fluid Dynamics for Incompressible Flows, Prof. Amaresh Dalal, Professor of ME, IIT Guwahati*
2. https://nptel.ac.in/courses/103106119; *NPTEL Video Lecture on Computational Fluid Dynamics, Prof. Sreenivas Jayanti, Professor of ME, IIT Madras*
3. https://nptel.ac.in/courses/112105045; *NPTEL Video Lecture on Computational Fluid Dynamics, Prof. S. Chakraborty, Professor of ME, IIT Kharagpur*

Course Articulation Matrix (CAM): U24ME612X POWER PLANT ENGINEERING

CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	U24ME612X.1	2	-	1	-	-	1	-	-	1	-	1	1	1
CO2	U24ME612X.2	2	-	1	-	-	1	-	-	1	-	1	1	1
CO3	U24ME612X.3	2	2	1	-	-	1	-	-	1	-	1	1	1
CO4	U24ME612X.4	2	2	1	-	-	1	-	-	1	-	1	1	1
U24ME612X		2	2	1	-	-	1	-	-	1	-	1	1	1

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	analyze the working principles of a nuclear power plant	SDG7	Affordable and Clean Energy	Nuclear power plants provide large-scale low-carbon electricity generation, contributing to clean and sustainable energy production
CO2	illustrate the working of steam power plants	SDG7	Affordable and Clean Energy	Steam power plants improve energy efficiency and support reliable electricity generation for sustainable development.
CO3	interpret the working of combined cycle power plants	SDG7	Affordable and Clean Energy	Combined power plants support reliable electricity generation for sustainable development.
CO4	evaluate various economic parameters of power plants	SDG8	Decent Work and Economic Growth	Evaluation of economic parameters in power plants promotes cost-effective energy production, industrial productivity, and sustainable economic growth.

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	OE	U24OE701Y	Open Elective – Management Basket	2	1	-	3	3
2	PEC	U24ME702	Program Elective - I/ MOOCs-I	2	1	-	3	3
3	PCC	U24ME703	Finite Element Methods	2	1	-	3	3
4	PCC	U24ME704	Additive Manufacturing	2	1	-	3	3
5	PCC	U24ME705	Production and Operations Management	2	1	-	3	3
6	PCC	U24ME706	FEM Laboratory			2	2	1
7	ELC	U24ME707	Internship Evaluation*	-	-	2	2	1
8	ELC	U24ME708	Major Project, Phase-1 / Industrial Internship - 1	-	-	8	8	4
Total:				**10**	**5**	**12**	**27**	**21**
Additional Learning@: Maximum credits allowed for Honors/Minor				**-**	**-**	**-**	**-**	**04**
Total credits for Honors/Minor students:				**-**	**-**	**-**	**-**	**25**

#MULTIDISCIPLINARY OPEN ELECTIVES: Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

@ List of courses for additional learning through MOOCs towards Honors/Minor in Engineering shall be prescribed by the department under Honors/ Minor Curricula

B. Tech Honors with Research

Students opting for B. Tech Honors with Research, shall complete Research Methodology Course (4 Credits) through MOOCS (OR) a workshop / FDP of not less than one week on "Research Methodologies" (4 Credits).

Internship Evaluation for the students opting B. Tech Honors with Research, will be done on the 2-Month Research internship-II.

Management Courses Basket		
Sr. No.	**Course Code**	**Course Title**
1.	U24OE701A	Management Economics and Accountancy
2.	U24OE701B	Finance for Engineers
3.	U24OE701C	Organizational Behaviour
4.	U24OE701D	E-Commerce and Digital Marketing
5.	U24OE701E	Any other course approved by BoS Chair and Dean AA

Program Elective - I/ MOOCs-I		
Sr. No.	**Course Code**	**Course Title**
1.	U24ME702A	Design of Thermal Equipment
2.	U24ME702B	Automobile Engineering
3.	U24ME702C	Modern Machining Processes
4.	U24ME702D	Industry 5.0
5.	U24ME702E	Any other course approved by BoS Chair and Dean AA

MANAGEMENT ECONOMICS AND ACCOUNTANCY			
Class: B. Tech. VII-Semester		**Branch: ME**	
Course Code:	**U24OE701A**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : comprehend the basic concepts of management, functions of management

CO2 : distinguish between micro & macroeconomics & forms of business organizations

CO3 : pass journal entries & post them into ledgers, prepare profit & loss accounts and assesses the financial position through the balance sheet

CO4 : evaluate financial statements with a the help of various ratios and reveal the financial health of the organization

UNIT-I	**9 Hrs**

Introduction to Management: Concept of Management, Features of Management, Importance of Management, Nature and Scope of Management, Fayol's Administrative Management, Taylor's Scientific Management

Functions of Management: Planning- Concept of Planning, Nature of Planning, Importance of Planning, Planning Process, Types of Planning; **Organizing**-Concept of Organizing, Organization Structure- line and staff, Advantages of Organizing; **Staffing** - Meaning, Functions of Human Resources Management; **Directing**- Elements of Directing- Supervision; Leadership- Nature; Motivation - Nature, Types; Communication- Process, Types, Barriers to effective communication; **Co-ordination**- Definition, Steps to achieve effective coordination; **Controlling**- Definition, Process

UNIT-II	**9 Hrs**

Economics: Meaning and definition, Scope, Micro and Macro Economics, Methods of Economics

Forms of Business Organization: Sole Proprietor ship, Partnership firm - Types of Partners, Limited Liability Partnership (LLP), Joint Stock Company - Features, Types, Merits and demerits, Cooperative society

UNIT-III	**9 Hrs**

Introduction to Financial Accounting: Accounting concepts and conventions, Double Entry System and Book Keeping, Overview of accounting cycle, Journal-meaning, Journalizing, Ledger - Meaning, Ledger posting, Balancing; Cash book (Single column), Preparation of Trial balance

Final Accounts: Trading Account, profit and loss account and Balance Sheet with simple adjustments

UNIT-IV	**9 Hrs**

Financial Statement Analysis: Introduction to Financial Statement Analysis**,** Ratio Analysis, Introduction, Types of Ratios, Analysis and Interpretation of Liquidity Ratios, Profitability ratios, Activity Ratios, and Capital structure Ratios (simple problems)

Textbook(s):

1. L.M.Prasad, *Principles and Practices of Management,* Sultan Chand & Sons Educational Publishers, 11th edition.2025, New Delhi. (Part –I to Part-VI)
2. D. N. Dwivedi, *Engineering Economics*: *Text & Cases*, Vikas Publishing, 5th edition, 2014. (Chapter-3)
3. R. Narayana Swamy, *Financial Accounting – A Managerial Perspective*, Prentice Hall of India, 7th edition, 2023,new Delhi.(Chapter VI)

Reference Book(S):

1. Harold Koontz and Heinz Weihrich, Essentials of Management, 6th ed. New Delhi: Tata Mc Graw Hill Publications, 2015.
2. Maheshwari, S. N., & Maheshwari, S. K. (2024). Financial Accounting (7th ed.). Vikas Publishing House Pvt. Ltd, 2024.

Web and Video link(s):

https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_mg52

https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_ec10

Course Articulation Matrix (CAM):														
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24MB701A.1	-	3	3	2	-	2	2	3	3	3	3	-	-
CO2	U24MB701A.2	-	2	2	-	-	2	3	3	3	3	3	-	-
CO3	U24MB701A.3	-	1	2	1	-	2	3	2	3	3	3	-	-
CO4	U24MB701A.4	-	2	2	2	-	1	2	-	3	2	3	-	-
U24MB701A		-	2	2.25	1.67	-	1.75	2.5	2.67	3	2.75	3	-	-
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	comprehend the basic concepts of management	SDG 4	Quality Education	Understanding the management concepts and managerial function will help the students to take effective and efficient decisions and able to solve work place problems.
CO2	distinguish between micro & macro-economics & forms of business organizations	SDG 8	Decent Work and Economic Growth	Economics concepts will help to promote sustained, inclusive and sustainable economic growth, and different forms of organizations will provide knowledge about creating full and productive employment and decent work for all
CO3	pass journal entries & post them into ledgers, prepare profit & loss accounts and assesses the financial position through the balance sheet	SDG 17	Partnerships for the goals	accounting concepts and conventions will promote a universal, rules-based, open, non-discriminatory and equitable application of
CO4	evaluate financial statements with a the help of various ratios and reveal the financial health of the organization	SDG 8	Decent Work and Economic Growth.	Evaluating financial statements through ratio analysis reveals the financial health of an organization, enabling better decision-making, efficient resource utilization, and sustainable growth.

FINANCE FOR ENGINEERS			
Class: B. Tech. VII -Semester		**Branch**: ME	
Course Code:	**U24OE701B**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: explain fundamentals of engineering finance, financial management objectives, ethics, and time value of money concept.

CO2 : apply capital budgeting techniques including inflation adjusted Net Present Value/Internal Rate Return for project evaluation and selection.

CO3: analyse various cost concepts and determine breakeven point for make or buy decisions in engineering projects.

CO4: evaluate asset replacement decisions and apply depreciation methods to determine the economic life and value of engineering assets.

UNIT-I	**9 Hrs**

Fundamentals of Engineering Finance

Engineering Finance – Meaning, Definition, and Scope; Role of Finance in Engineering – Importance for engineers in decision making and cost control; Ethics in Engineering Finance – Transparency, Cost estimation honesty, Avoidance of financial conflicts of interest; Financial Management – Meaning, Functions, Objectives (profit maximization v/s. wealth maximization), Sources of Finance, Time value of Money

UNIT-II	**9 Hrs**

Investment Decisions

Investment Decisions- Types of Investment projects, Investment evaluation criteria; Methods of capital budgeting – Discounted cash flow techniques v/s. non discounted cash flow techniques, Inflation adjusted NPV and IRR, Comparison and selection of mutually exclusive engineering projects

UNIT-III	**9 Hrs**

Cost-Volume-Profit Analysis

Cost concepts- Fixed, Variable, Marginal, Sunk, Opportunity costs, Direct and Indirect costs; Breakeven analysis – Meaning, Assumptions, Graphical and Mathematical determination of breakeven point; Make or buy decisions using breakeven analysis; Application of breakeven analysis in engineering projects

UNIT-IV	**9 Hrs**

Replacement Decisions and Valuation of engineering assets

Replacement analysis – Meaning, Need, Defender v/s. Challenger concept; Economic service life; Valuation of equipment's and physical assets - Depreciation definition, Depreciation fund; Methods of depreciation - straight line, Declining balance, Sum of the years-digits, Sinking fund and Service output method, Application of depreciation methods on equipment's and physical asset with the passage of time.

Textbook(s):

1. M Y Khan and P K Jain, *Financial Management,* Tata McGraw Hill 5th edition, ISBN:978-0-07-065614-7 *(Unit-I in part 1 of section 1,2&3 and Unit-II in part 3 of 9&10).*
2. R. Panneerselvam, *Engineering Economics,* PHI Learning 2nd edition, ISBN:978-81-203-4837-0 *(Unit-III in Chapter 1&16 and Unit-IV in Chapter 8& 9).*

Reference Book(S):

1. F.K. Crundwell, *Finance for Engineers: Evaluation and Funding of Capital Projects*, Springer London Ltd, Atlantic Publishers and Distributors (P) Ltd., ISBN: 978-1849967082, 2010.
2. Robert L. Kosowski, Salih N. Neftci, *Principles of financial engineering*, Academic press, Atlantic Publishers and Distributors (P) Ltd. 3rd edition, ISBN: 978-0123869685, 2014.

3. D. N. Dwivedi, *Engineering Economics: Text & Cases*, Vikas Publishing, 5th edition, ISBN: 9788126510887, 2014.
4. Prasanna Chandhra, *Financial Management: Theory and Practice,* Tata Mc Graw Hill Education (India) private limited, ISBN-10: 93-392-1225-8, 2015.
5. Chan S. Park, *Fundamentals of Engineering Economics,* Pearson Education. 3rd edition, ISBN: 978-9352864379, 2017.
6. Chatterjee Partha Sheikh Salim, *Engineering Economy & Financial Management*, Himalaya Publishing House, ISBN:978-9350247389, 2011.

Course Articulation Matrix (CAM):

CO		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PSO 1	PSO 2
CO1	**U24OE701B.1**	2	-	-	-	-	-	2	-	-	2	2	-	-
CO2	**U24OE701B.2**	-	3	-	-	2	-	-	-	-	-	3	-	-
CO3	**U24OE701B.3**	-	-	2	-	-	-	-	2	-	2	-	-	-
CO4	**U24OE701B.4**	-	-	2	2	-	2	-	-	-	2	2	-	-
		2	3	2	2	2	2	-	2	-	2	2.3	-	-
3 – HIGH, 2 – MEDIUM, 1 – LOW														

CO–SDG Alignment Matrix

CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	Explain fundamentals of engineering finance, financial management objectives, ethics, and time value of money concept.	SDG 4 And SDG 16	Quality Education and Peace, Justice and Strong Institutions	Promotes financial literacy, ethical decision-making, and professional responsibility essential for quality education and transparent institutional practices.
CO2	Apply capital budgeting techniques including inflation adjusted NPV/IRR for project evaluation and selection.	SDG 8 And SDG 9	Decent Work and Economic Growth And Industry, Innovation and Infrastructure	Supports economically viable investment decisions, efficient resource allocation, industrial growth, and sustainable infrastructure development.
CO3	Analyse various cost concepts and determine breakeven point for make or buy decisions in engineering projects.	SDG 9 And SDG 12	Industry, Innovation and Infrastructure and Responsible Consumption and Production	Encourages cost efficiency, optimized production planning, and responsible utilization of resources in engineering and industrial projects
CO4	Evaluate asset replacement decisions and apply depreciation methods to determine the economic life and value of engineering assets.	SDG 8 And SDG 12	Decent Work and Economic Growth and Responsible Consumption and Production	Promotes sustainable asset management, economic efficiency, lifecycle optimization, and responsible use of engineering resources.

ORGANIZATIONAL BEHAVIOUR			
Class: B. Tech. VII – Semester		Branch: ME	
Course Code:	**U24OE701C**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**40%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**60%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : evaluate the fundamentals, importance, influencing factors, and communication processes of Organizational Behaviour.

CO2 : analyse individual behaviour including personality, perception, learning, attitudes, emotions, stress, and motivation.

CO3 : examine group behaviour, team effectiveness, conflict management, leadership, power, politics, and group dynamics in organizational settings.

CO4 : evaluate organizational structure, culture, innovation, change, organizational effectiveness, quality of work life, and international organizational behaviour.

UNIT-I	**9 Hrs**

Introduction: Foundations of organizational behavior, Concept, Importance, Factors influencing organizational behavior, Challenges and opportunities for organization behavior; Managerial perspective of OB; Communication-Process-channels-communication barriers , Measures to overcome barriers

UNIT-II	**9 Hrs**

Individual Behavior: Individual in the organization, Nature of man, Models of man, Personality-Stages of development of personality; Perception-Factors influencing perception; Learning-Theories of Learning-Cognitive Learning Theory, Behaviourist Learning Theory; Attitudes-Formation of attitudes; Personality and emotions, Managing emotions and stress in organizations; Motivation- Motivation theories-Maslow's Needs Hierarchy Theory and Herzberg's Two-Factor Theory

UNIT-III	**9 Hrs**

Group decision making: Groups in organization, Basic group concepts, Groups vs. Teams, Understanding work teams-Types of teams, Creating effective teams; Conflicts-Types of conflicts, Strategies for resolution of conflicts in groups

Group dynamics: Group dynamics, Leadership-Leadership types and managerial effectiveness, Trust and leadership, Power and politics, Basis of power, Organizational politics

UNIT-IV	**9 Hrs**

Organization structure: Organization structure, Size and design; Organizational culture; Organizational change-Resistance to change; Organizational stress- Factors contribute to stress, Coping strategies, Stress and performance; Organizational effectiveness-concepts; Quality of work life-concepts; International organizational behavior-concepts

Textbook(s):

1. Stephen P. Robbins, Timothy A. Judge & Neharika Vohra, *Organizational Behavior, Pearson India, 18th edition*, 2022, New Delhi. (Chapter I to IV)
2. K. Aswathappa, *Organizational Behaviour, Himalaya Publishing House, 14th edition*, 2021, Mumbai. (Chapter I to IV)

Reference Book(S):

1. Fred Luthans, *Organizational Behavior, McGraw Hill Education, 13th edition*, 2020, New York.
2. Uma Sekaran, *Organizational Behavior: Text and Cases, McGraw Hill Education, 2nd edition*, 2019, New Delhi.
3. S. S. Khanka, *Organizational Behavior, S. Chand Publishing, 11th edition*, 2021, New Delhi.

Web and Video link(s):

1. Harvard Business Review – Organizational Behavior Articles and Videos; Web resources and expert videos on leadership, teamwork, communication, conflict management, and organizational effectiveness.

Course Articulation Matrix (CAM):		U24OE701C ORGANIZATIONAL BEHAVIOUR												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24OE701C.1	2	-	-	-	-	-	-	2	2	-	-	-	-
CO2	U24OE701C.2	-	3	-	-	-	-	2	--	-	-	3	-	-
CO3	U24OE701C.3	-	2	-	-	-	-	-	2	2	2	-	-	-
CO4	U24OE701C.4	-	-	2	-	-	2	-	-	-	2	2	-	-
U24OE701C		2	2.5	2	-	-	2	2	2	2	2	2.5	-	-
3 – HIGH, 2 – MEDIUM, 1 – LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Explain the fundamentals, importance, influencing factors, and communication processes of Organizational Behaviour.	SDG 4	Quality Education	Understanding organizational behaviour and communication processes helps students develop professional knowledge, communication, and workplace learning skills.
CO2	Analyse individual behaviour including personality, perception, learning, attitudes, emotions, stress, and motivation.	SDG 3	Good Health and Well-being	Analysing emotions, stress, motivation, and attitudes promotes mental well-being, self-management, and healthy work practices.
CO3	Examine group behaviour, team effectiveness, conflict management, leadership, power, politics, and group dynamics in organizational settings.	SDG 16	Peace, Justice and Strong Institutions	Studying leadership, conflict management, teamwork, and group dynamics supports inclusive, cooperative, and effective organizational practices
CO4	Evaluate organizational structure, culture, innovation, change, organizational effectiveness, quality of work life, and international organizational behaviour.	SDG 8	Decent Work and Economic Growth	Evaluating organizational culture, innovation, quality of work life, and change management supports productive employment and sustainable organizational growth.

E-COMMERCE & DIGITAL MARKETING			
Class: B. Tech. VII – Semester		**Branch:** ME	
Course Code:	**U24OE701D**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : interpret the concepts, scope, types, functions, framework, opportunities, and limitations of E-Commerce, and analyse its role in modern business and electronic transactions

CO2 : analyze e-payment systems, e-finance operations, e-banking, e-trading, and the legal framework governing e-commerce transactions

CO3 : evaluate digital marketing practices, emerging trends, and consumer behaviour in the online environment

CO4 : determine digital marketing channels and design effective online marketing plans

UNIT-I	**9 Hrs**

Introduction to E-Commerce: E-Commerce – Introduction, Definition, Scope, Evolution, Internet Commerce vs E-Commerce; Electronic Commerce Market; E-Commerce Industry Framework; Trade Cycle in E-Commerce; Electronic Data Interchange (EDI); E-Commerce Functions; Types of E-Commerce – B2B, B2C, C2C, C2B, B2G, G2B, and G2C; Forces fuelling E-Commerce – Differences between Traditional Commerce and E-Commerce; Limitations of E-Commerce; Introduction to Artificial Intelligence (AI) in E-Commerce

UNIT-II	**9 Hrs**

E-payment Systems: Digital payment Requirements; Types of E-Payment Systems - Digital Token-based E-payment systems, Credit card as E-payment system, Mobile payments, smart card cash payment system, Micropayment system, E-Security, E- Cash; E-Finance: Areas of Financing; E-Banking - Traditional Banking Vs. E-Banking; Operations in E-Banking; E-Trading – Stock Market trading; Importance and advantages of E-Trading

Legal Framework for E-Commerce: E-Commerce Legal Framework - The Information Technology Act 2000, Information Technology (Amendment) Act, 2008, Copyrights, Defamation, Privacy, Contracts, Taxation, Signing a contract Electronically, Domain name and Registration

UNIT-III	**9 Hrs**

Digital Marketing: Concept, Components of Digital Marketing, Need and Scope of Digital Marketing, Benefits of Digital Marketing, Digital Marketing Platforms and Strategies, Comparison of Marketing and Digital Marketing, Digital Marketing Trends, Marketing in the Digital Era: Segmentation – Importance of Audience Segmentation, different segments used in Digital Media – Organizational characteristics, purchasing characteristics, using Digital Media to Reach, acquisition and retention of new customers, Digital Media for Customer Loyalty

UNIT-IV	**9 Hrs**

Channels of Digital Marketing: Digital Marketing, Website Marketing, Search Engine Marketing, Search Engine optimization, Online Advertising, Email Marketing-Campaign Design, Automation, Personalization, Blog Marketing-Content Creation, Blogging Platforms, Social Media Marketing-Marketing through Facebook, Instagram, LinkedIn, X (Twitter), and youtube, Audio, Video and Interactive Marketing, Mobile Marketing; Digital Marketing Plan: Need for Digital Marketing Plan, Elements of Digital Marketing Plan, Writing the Marketing Plan and Implementation

Textbook(s):

1. C. S. V. Murthy- *E-Commerce: Concepts, Models & Strategies*, Himalaya Publishing House 2nd Edition (2025).
2. Seema Gupta – *Digital Marketing*, McGraw-Hill 3rd Edition, 2022/2023.
3. Tracy L. Tuten & Michael R. Solomon – *Social Media Marketing*, SAGE Publication, 5th Edition, 2023.

Reference Book(S):

1. Matthew Reynolds – *Beginning E-Commerce with Visual Basic, ASP, SQL Server 7.0 & MTS*, published by Wrox Publisher.
2. P. T. Joseph, S.J. *E-Commerce: An Indian Perspective, Latest Edition*: 7th Edition (2023) Publisher: PHI Learning Pvt. Ltd.
3. Michael Miller – *B2B Digital Marketing: Using the Web to Market Directly to Businesses* 1st Edition (2012; Indian reprint 2014/2015) Pearson India / Que Publishing.

Web and Video link(s):

1. **https://youtu.be/qnBhOVH1QQ8?si=6UtzpR5d6t8Rk5da Digital Marketing Full Course 2026 In 24 Hrs | Digital Marketing Tutorial For Beginners**
2. https://youtu.be/qsO_YCjgBFI?si=zVdKwrU8l6eEr4wg

Course Articulation Matrix (CAM):		U24OE701D-E-COMMERCE & DIGITAL MARKETING												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24OE701D.1	2	2	1	-	2	1	-	-	1	-	2	-	-
CO2	U24OE701D.2	2	2	1	1	2	2	1	-	1	1	1	-	-
CO3	U24OE701D.3	2	2	2	1	2	1	1	1	2	1	2	-	-
CO4	U24OE701D.4	2	2	2	2	2	1	1	2	2	2	2	-	-
U24OE701D		2	2	1.5	1.3	2	1.25	1	1.5	1.5	1.3	1.75	-	-
3 – HIGH, 2 – MEDIUM, 1 – LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Understand the concepts, scope, types, functions, framework, opportunities, and limitations of E-Commerce, and analyse its role in modern business and electronic transactions.	**SDG 8**	Decent Work and Economic Growth	E-Commerce promotes entrepreneurship, digital business growth, employment opportunities, and innovation in the global economy
CO2	Analyse e-payment systems, e-finance operations, e-banking, e-trading, and the legal framework governing e-commerce transactions.	**SDG 9**	Industry, Innovation and Infrastructure	Digital payment systems and e-banking strengthen technological infrastructure, financial inclusion, and innovation in digital industries.
CO3	Evaluate digital marketing practices, emerging trends, and consumer behaviour in the online environment.	**SDG 12**	Responsible Consumption and Production	Digital marketing helps organizations understand consumer behaviour and promote sustainable and responsible consumption patterns.
CO4	Analyze digital marketing channels and design effective online marketing plans.	**SDG 17**	Partnerships for the Goals	Digital marketing channels improve global communication, collaboration, networking, and partnerships among businesses and stakeholders

DESIGN OF THERMAL EQUIPMENT			
Class: B. Tech. VII–Semester		**Branch:** ME	
Course Code:	**U24ME702A**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from the theory component)

CO1: design heat exchangers by using LMTD and NTU methods

CO2 : determine heat transfer rate of a double pipe heat exchanger

CO3: analyze compact heat exchangers and evaporators

CO4: evaluate performance of two-phase heat exchanger and micro-channels

UNIT-I	9 Hrs

Heat exchangers: Classification, applications, flow arrangements, temperature distributions and selection considerations; basic design methods-overall heat transfer coefficient (U), Logarithmic Mean Temperature Difference (LMTD), effectiveness (ε), Number of Transfer Units (NTU); design of heat exchangers subject to fouling

UNIT-II	9 Hrs

Convection Correlations: Laminar forced convection in ducts and concentric annuli; turbulent forced convection in circular pipes, heat transfer in helical coils, spirals and bends

Double pipe heat exchangers: Design process and calculations – heat transfer area, heat transfer coefficient, total pressure drop, hydraulic diameter; hairpin heat exchanger-parallel and series arrangements, shell side pressure drop, tube side pressure drop and performance analysis

UNIT-III	9 Hrs

Compact heat exchangers: Plate-fin, tube-fin and gasketed plate; heat transfer and pressure drop calculations

Evaporators: Classification - natural and forced, refrigerant flow inside or outside, flooded and dry type; thermal design - heat transfer area, overall heat transfer coefficient and enhancement; Wilson's plot

UNIT-IV	9 Hrs

Thermosyphons and Heat Pipes: Design; thermal and hydraulic models – applications

Two-phase heat exchangers: Classification, working principle, applications and thermal analysis of tubular, plate-type and extended surface type heat exchangers; micro-channel technology-working principle, benefits and thermal analysis

Textbook(s):

1. Kakac S., Liu H., and Pramunjaroenkij A, *Heat Exchangers: Selection Rating and Thermal Design,* 4th ed., New York: CRC Press Taylor & Francis Group, 2020. (*Chapters 1 to 4 and 6 to 12)*
2. Mantelli and Marcia B. H., *Thermosyphons and Heat pipes: Theory and Application*, Switzerland: Springer Nature, 2021. (*Chapters 1 to 4, 6, 9 to 11)*

Reference Book(s):

1. Serth R.W, *Process heat transfer principles and applications*, Academic press: Elsevier, 2nd ed., 2014.
2. Das S. K., *Process heat transfer,* New Delhi: Narosa Publishing House, 10th ed., 2009.
3. Kern D.Q, *Process Heat Transfer*, New Delhi: McGraw-Hill, 2nd ed., 1988.

Data Book:

1. C. P. Kothandaraman, *Heat and Mass Transfer Data Book*, New age International publishers, New Delhi, 2018.

Web and Video link(s):

1. *https://nptel.ac.in/courses/112105248 NPTEL Video Lecture on Heat Exchangers: Fundamentals and Design Analysis by Prof. Prasanta Kumar Das Professor of Mechanical Engineering & Prof. Indranil Ghosh, Department of Cryogenic Engineering, IIT Kharagpur.*

Course Articulation Matrix (CAM):		U24ME702A: DESIGN OF THERMAL EQUIPMENT												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME702A.1	2	2	2	2	-	1	-	-	1	-	1	2	2
CO2	U24ME702A.2	2	2	2	2	-	1	-	-	1	-	1	2	2
CO3	U24ME702A.3	2	2	2	2	-	1	-	-	1	-	1	2	2
CO4	U24ME702A.4	2	2	2	2	-	1	-	-	1	-	1	2	2
U24ME702A		2	2	2	2	-	1	-	-	1	-	1	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	design heat exchangers by using LMTD and NTU methods	SDG9	Industry, Innovation and Infrastructure	Designing efficient heat exchangers promotes advanced industrial systems, energy-efficient technologies, and sustainable infrastructure development.
CO2	determine heat transfer rate of a double pipe heat exchanger	SDG7	Affordable and Clean Energy	Efficient heat transfer analysis improves thermal energy utilization and supports energy conservation in industrial applications.
CO3	analyze compact heat exchangers and evaporators	SDG12	Responsible Consumption and Production	Compact heat exchangers and evaporators enhance resource efficiency, reduce energy wastage, and support sustainable production processes.
CO4	evaluate performance of two-phase heat exchanger and micro-channels	SDG9	Industry, Innovation and Infrastructure	Advanced two-phase heat exchangers and micro-channel technologies contribute to innovative thermal management systems and modern industrial applications.

AUTOMOBILE ENGINEERING			
Class: B. Tech. VII – Semester		**Branch:** ME	
Course Code:	**U24ME702B**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : *classify automobiles and explain elements of transmission system like clutch, gear box and automatic transmission*

CO2 : *examine the working principle of propeller shaft, axle and explain various parts of steering system, braking system*

CO3 : *illustrate suspension system elements, wheels, tyres and electrical system*

CO4 : *analyze lubrication and cooling systems, emission norms and current trends of automobiles*

UNIT-I	**9 Hrs**

Automobile: Introduction, classification and parts; Chassis- chassis layout; frames **Transmission system:** Requirements, types and elements

Clutch-Function, types- friction clutches - single plate, multi-plate, centrifugal and semi-centrifugal; automatic transmission device- fluid flywheel

Gear box: Types-sliding mesh, constant mesh, synchromesh and automatic gear box; over drive

UNIT-II	**9 Hrs**

Propeller shaft: Types- Hotchkiss and torque tube; final drive and differential

Axle System: Functions; front axle types -rigid and independent; rear axle mounting **Steering system:** Principle, need, layout, steering gear, steering ratio, steering lock, turning radius, wheel geometry; Power steering- hydraulic and electronic

Braking system: Classification, principle, requirements; types- disc, hydraulic, power and servo; automatic and antilock braking system

UNIT-III	**9 Hrs**

Suspension system: Functions, elements, torsion bars, stabilizer bars and shock absorbers; types- rigid axle, solid leaf spring and coil spring, air suspension

Wheels: Assembly, pressed and cast wheel; wheel rim; wheel balancing

Tyre: Specifications, construction, tyre treads and tubeless tyres

Electrical systems: Wiring diagram, head lights- high beam, restricted high beam; electrical circuits- flashers, horn and wiper; air-conditioning; heating and ventilating

UNIT-IV	**9 Hrs**

Lubrication: Functions, properties; types - splash, pressure, dry sump, wet sump and mist; cooling systems: Air cooling, water-cooling and oil cooling

Emissions and Control: Effects of emissions, pollution control, Euro norms, Bharat norms; testing devices, engine tuning, engine re-boring; vehicle standard service and maintenance **Current Trends in Automobiles:** autonomous, artificial intelligence and machine learning, electric vehicle, hybrid electric vehicle and solar vehicle

Textbook(s):

1. Srinivasan, S, "*Automotive Mechanics', 2nd ed., Tata McGraw-Hill, 2003.*

Reference Book(S):

1. Dr. Kirpal Singh, —*Automobile Engineering*, Vol. I & II, 14th ed., Standard Publishers, NewDelhi,2017
2. R. K. Rajput —*Automobile Engineering*", 2nd ed., Laxmi Publishers, 2017.
3. Kamaraju Ramakrishna, "*Automobile Engineering*", 1st ed., PHI Learning, New Delhi, 2016.

4. William H.Crouse and Donald L. Anglin "*Automotive Mechanics*", 10th ed., Tata McGraw-Hill, 2006
5. Joseph Heitner "*Automotive Mechanics Principles and Practices*" 2nd ed., CBS Publishers & Distributors Pvt. Ltd, 2004.
6. K M Gupta, *Automobile Engineering*, Vol. I & II, Delhi, Umesh Publications, 2002.

Web and Video link(s): *NPTEL Video Lecture on* **AUTOMOBILE ENGINEERING**

https://elearn.nptel.ac.in/shop/nptel/fundamentals-of-automotive-systems *Professor C. S. Shankar Ram, IIT Madras*

Course Articulation Matrix (CAM):		**U24ME702B: AUTOMOBILE ENGINEERING**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME702B.1**	2	1	1	-	-	1	-	1	-	-	1	1	1
CO2	**U24ME702B.2**	2	1	1	-	-	1	-	1	-	-	1	1	1
CO3	**U24ME702B.3**	2	1	1	-	-	1	-	1	-	-	1	1	1
CO4	**U24ME702B.4**	2	1	1	-	-	1	-	1	-	-	1	1	1
U24 ME 702B		2	1	1	-	-	1	-	1	-	-	1	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	*classify automobiles and explain elements of transmission system like clutch, gear box and automatic transmission*	SDG 9	Build resilient infrastructure, promote sustainable industrialization and foster innovation.	Understanding transmission systems helps students gain knowledge of efficient automotive design and modern industrial technologies. Concepts such as automatic transmission, gear mechanisms, and drivetrain efficiency support innovation in automobile manufacturing and contribute to the development of sustainable and reliable transportation infrastructure.
CO2	*examine the working principle of propeller shaft, axle and explain various parts of steering system, braking system*	SDG 7	Ensure access to affordable, reliable, sustainable and modern energy for all	Efficient steering, braking, and power transmission systems improve vehicle performance and reduce energy losses. Knowledge of these systems supports the design of fuel-efficient and energy-optimized automobiles, contributing to sustainable transportation and efficient energy utilization.
CO3	*illustrate suspension system elements, wheels, tyres and electrical system*	SDG 12	Ensure sustainable consumption and production patterns.	Studying tyres, suspension, and automotive electrical systems promotes awareness of material efficiency, maintenance practices, recycling, and responsible use of automotive components. Proper design and maintenance reduce wastage, improve vehicle lifespan, and encourage sustainable production and consumption practices in the automobile sector.
CO4	*explain lubrication and cooling systems, emission norms and current trends in automobiles*	SDG 11	Make cities and human settlements inclusive, safe, resilient, and sustainable	Knowledge of lubrication, cooling systems, and emission norms helps reduce vehicle pollution and improve environmental sustainability. Understanding modern automotive trends such as electric and hybrid vehicles supports cleaner transportation systems, contributing to safer and more sustainable urban environments.

MODERN MACHINING PROCESSES

Class: B. Tech. VII – Semester		**Branch:** ME	
Course Code:	**U24ME702C**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : distinguish mechanical energy-based processes

CO2 : demonstrate electrical energy-based processes

CO3 : select suitable chemical energy-based processes for a given material and form

CO4 : illustrate thermal energy-based processes

UNIT-I	9 Hrs

Introduction: Comparison of conventional and unconventional machining processes, Technological and commercial need, classification, Applications.

Mechanical Energy Based Processes: Ultrasonic Machining (USM)-working principles, process parameters, material removal rate, and surface finish, applications, advantages and limitations; Abrasive Jet Machining (AJM)-elements of the process, types of abrasives, process parameters, advantages applications and limitations; Water Jet Machining (WJM) – working principle, jet cutting equipment, applications, advantages and limitations; Magnetic Abrasive Machining- working principle, applications, advantages and limitations.

UNIT-II	9 Hrs

Electrical Energy Based Processes: Electrical Discharge Machining (EDM)-Classification, Working principle of die sink EDM, mechanism of material removal, feed mechanism, process parameters, analysis of R-C circuit, equations for material removal rate and surface finish, electrode materials and dielectric fluids applications, advantages and limitations; **Wire EDM** and **Micro EDM** - working principle, applications , advantages and limitations; **Hybrid Process**- Electrical Discharge Grinding (EDG), working principle and applications, advantages and limitations.

UNIT-III	9 Hrs

Chemical Energy Based Processes: Chemical Machining (CHM)- working principle, equipment, etchants and maskants, applications, advantages and limitations; Electro Chemical Machining (ECM) **-** working principle, chemistry of the process, process parameters, material removal rate and surface finish, applications, advantages and limitations;

Hybrid Processes-Electro chemical grinding (ECG), electro chemical deburring (ECD) and electro chemical honing, (ECH) - working principles advantages, limitations and applications.

UNIT-IV	9 Hrs

Thermal Energy Based Processes: Plasma arc machining (PAM)- working principle, process parameters, types of torchesadvantages and advantages and limitations; Electron beam machining (EBM) - working principle, accuracy and surface finish, applications, advantages and limitations; Laser beam machining (LBM)-production of lasers, types of lasers, material removal, applications, advantages and limitations; Ion Beam Machining (IBM)- working principle, applications , advantages and limitations.

Textbook(s):

1. P. C. Pandey and H.S. Shah, *Modern Machining Processes*, New Delhi: McGraw Hill Publications, 2012.

Reference Book(S):

1. V. K. Jain, *Advanced Machining Processes*, New Delhi: Allied Publications Limited, 2010.
2. Carl Sommer, *Non-traditional Machining Handbook*, Texas: Advance Publishing Inc., 2009.

3. HMT *Production Technology Handbook*, New Delhi: Tata McGraw Hill, 2008.
Web and Video link(s):
https://nptel.ac.in/courses/112103202; *NPTEL Video Lecture on Advanced Machining Processes by Prof. Manas Das, Professor of Mechanical Engineering, IIT Guwahati.*

Course Articulation Matrix (CAM):		**U24ME702C: MODERN MACHINING PROCESSES**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME702C.1**	2	2	1	-	-	1	-	-	1	-	1	2	1
CO2	**U24ME702C.2**	2	2	1	-	-	1	-	-	1	-	1	2	1
CO3	**U24ME702C.3**	2	2	1	-	-	1	-	-	1	-	1	2	1
CO4	**U24ME702C.4**	2	2	1	-	-	1	-	-	1	-	1	2	1
U24ME702C		2	2	**1**	**1**	**-**	**1**	**-**	**-**	**1**	**-**	**1**	**2**	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	distinguish mechanical energy-based Processes	**SDG 9**	**Industry, Innovation & Infrastructure**	Focuses on understanding foundational advanced manufacturing infrastructure, optimizing material removal rates, and upgrading technological capabilities in industrial tool design.
CO2	demonstrate electrical energy-based processes	SDG 12	**Responsible Consumption & Production**	Requires assessing substantial electrical energy consumption, maximizing thermal/spark efficiency, and analyzing the carbon footprint of manufacturing power supplies.
CO3	select suitable chemical energy-based processes for a given material and form	SDG 12	**Responsible Consumption & Production**	Demands selection criteria based on chemical etchant toxicity, management of hazardous chemical wastes/sludge, and the design of neutralisation or recycling systems.
CO4	illustrate thermal energy-based processes	SDG 12	**Responsible Consumption & Production**	Deals with high-intensity localized thermal energy systems. Selection must balance high-precision product creation with mitigating emissions and greenhouse gases from vaporized materials.

Industry 5.0			
Class: B. Tech. **VII** – Semester		**Branch:** ME	
Course Code:	**U24ME702D**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : analyze the evolution of industrial revolutions, digitalization, Industry 5.0 drivers, smart factories, industrial big data, and predictive analytics for modern industrial transformation.

CO2 : apply IoT, IIoT, Internet of Services, predictive analytics, and smart logistics concepts for intelligent industrial applications and smart product development.

CO3 : analyze cyber-physical systems, collaborative robots, artificial intelligence, cybersecurity, mobile computing, and human-centric approaches in Industry 5.0 environments.

CO4 : design and evaluate Industry 5.0 solutions using additive manufacturing, healthcare technologies, renewable energy systems, intelligent wireless networks, and industrial automation applications.

UNIT-I	9 Hrs

Introduction to Industry 5.0 : Introduction of various industrial revolutions, digitalisation and the networked economy, drivers, enablers, compelling forces and challenges for industry 5.0, comparison of industry 5.0 factory and today's factory, trends of industrial big data and predictive analytics for smart business automation and transformation processes.

UNIT-II	9 Hrs

Importance of Internet of Things (IOTs): Introduction to Internet of Things (IoT), Industrial Internet of Things (IIoT), internet of services, fundamental of predictive analytics, smart logistics, smart devices and products.

UNIT-III	9 Hrs

Technology Evolution: Basics of cyber Physical Systems, process automations and collaborative robots, fundamental to artificial intelligence, mobile computing, cyber security, ethical technology, responsive and distributed supply chain system, human-centric and value-oriented approaches.

UNIT-IV	9 Hrs

Technology Implementation and Case Studies : 3D printing, solar energy sector, healthcare sector, maintain records related to education, finance, clean bio energy generation and intelligent next g wireless networks. case studies on CNC/NC automation, in-house, healthcare services.

Textbook(s):

1. Uthayan Elangovan, Industry 5.0, "*The Future of the Industrial Economy*", First edn.,, Taylor & Francis, ISBN: 978-1-032-04127-8, 2022.
2. Alessandro Massaro, "*Electronics in Advanced Research Industries: Industry 4.0 to Industry 5.0 Advances*", Wiley-IEEE Press, 2021, ISBN: 2021028944.

Reference Book(S):

1. Janya Chanchaichujit, Albert Tan, Fanwen Meng, Sarayoot Eaimkhong, "*Healthcare 4.0 Next Generation Processes with the Latest Technologies*", Palgrave Pivot, 2019, ISBN978-981-13-8113-3.

2. Charles J. Brooks, Philip A. Craig Jr., "*Practical Industrial Cybersecurity*", John Wiley & Sons, Inc., Hoboken, New Jersey, 2022, ISBN: 978-1-119-88302-9.
3. Le, Chung Van; Le, Dac-Nhuong; Nguyen, Nhu Gia; Tromp, Jolanda G, "*Emerging Technologies for Health and Medicine*", John Wiley & Sons; Salem, 2018, ISBN: 978-1- 119-50981-3,1119509815.

Web and Video link(s):

https://nptel.ac.in/courses/106105195; *NPTEL Video Lecture on* Introduction to Industry 4.0 and Industrial Internet of Things. *by Prof. Prabir Kumar Biaswas, Professor Sudip Misra,Department of Computer Science and Engineering, IIT Kharagpur.*

Course Articulation Matrix (CAM):		**U24ME702D : Industry 5.0**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME702D.1**	2	2	1	-	2	1	-	-	1	-	1	2	1
CO2	**U24ME702D.2**	2	2	1	-	2	1	-	-	1	-	1	2	1
CO3	**U24ME702D.3**	2	2	1	-	2	1	-	-	1	-	1	2	1
CO4	**U24ME702D.4**	2	2	1	-	2	1	-	-	1	-	1	2	1
U24ME702D		2	2	1	-	2	1	-	-	1	-	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Understand Industry 5.0 concepts, industrial revolutions, digitalization, smart factories, and predictive analytics	SDG9	Industry, Innovation and Infrastructure	Industry 5.0 promotes smart manufacturing, industrial automation, and digital transformation through advanced technologies, enhancing innovation and sustainable industrial infrastructure.
CO2	Apply frequency domain filtering, restoration and reconstruction techniques	SDG11	Sustainable Cities and Communities	IoT and smart devices enable intelligent transportation, smart logistics, energy-efficient systems, and connected infrastructure that contribute to sustainable and smart communities.
CO3	Apply morphological processing and segmentation techniques	SDG8	Decent Work and Economic Growth	Human-centric automation and collaborative robotics improve worker safety, productivity, and skill development while promoting sustainable economic growth and decent industrial employment.
CO4	Apply feature extraction and classification techniques	SDG7	Affordable and Clean Energy	Industry 5.0 applications such as solar energy systems, clean bio energy generation, and intelligent energy management support sustainable and clean energy solutions.

FINITE ELEMENT METHODS

Class: B. Tech. VII– Semester		**Branch: ME**	
Course Code:	**U24ME703**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : apply finite element formulation to one-dimensional bar problems and convergence analysis.

CO2 : evaluate truss and beam problems to determine displacements, reactions, and stresses using FEM.

CO3 : formulate CST, LST, and quadrilateral finite elements for two-dimensional elasticity and isoperimetric problems.

CO4 : analyse heat transfer, vibration, and elasticity problems using finite element methods

UNIT-I	**9 Hrs**

Introduction: Basic concept and General Description of the Finite Element Method, Comparison of Finite Element Method with other methods of analysis, Engineering Applications of the Finite Element Method, Advantages and Limitations of the Finite Element Method; Discretization of the Domain, Discretization Process, Types of Elements, Element Division; Element Stiffness Matrix, Properties of Stiffness Matrix, Assembly of Global Stiffness Matrix and Load Vector, Formulation of Finite Element Equations; Types of Boundary conditions, Treatment of Boundary Conditions; Convergence of Finite Element Solutions.

One-Dimensional Problems: Bar Elements - Interpolation and Shape functions, Element Stiffness Matrix, Assembly of Global Stiffness Matrix and Load Vector, Application of Boundary Conditions, Solution for Displacements, Reactions, Stresses, Temperature Effects.

UNIT-II	**9 Hrs**

Truss Elements: Interpolation and Shape functions, Plane Truss, Local and Global Coordinate Systems, Element Stiffness Matrix and Stress Calculations.

Beam Elements: Interpolation and Shape functions, Derivation of Element Stiffness Matrix, Finite Element Formulation, Load Vector, Boundary Considerations, Solution for Slope, Deflection, Reactions, and Stresses.

UNIT-III	**9 Hrs**

Two -Dimensional Problems: Derivation of Finite Element Equations using Principle of Virtual Work; Interpolation and Shape Functions of Basic Elements - Constant Strain Triangle (CST), Linear Strain Triangle (LST) and Four-Node Rectangular Element.

Isoparametric Formulation: Definition and Concept, Natural Coordinate System, Mapping of Elements, Jacobian Matrix, Four-Node Quadrilateral, Shape Functions, Element Stiffness.

UNIT-IV	**9 Hrs**

Applications in Heat Transfer: Steady State Heat Transfer, One-Dimensional Heat Conduction, One-Dimensional Heat Transfer in Fins.

Structural Dynamics: Dynamic Equations of Motion, Element Mass Matrices, Evaluation of Eigen values and Eigen Vectors.

Weighted Residual and Variational Methods: Principle of Minimum Potential Energy, Galerkin's method and Rayleigh–Ritz's method.

Textbook(s):

1. Chandrupatla T. R. and Belegundu A. D., Introduction to Finite Elements in Engineering, Prentice Hall India, 4th Edition, 2012. (Chapters 1 to 5, 7 and 8)

Reference Book(S):

1. Singiresu S. Rao, The Finite Element Method in Engineering, Massachusetts: Elsevier Butterworth-Heinemann, 6th edition, 2017.

2. David V. Hutton, Fundamentals of Finite Element Analysis, Tata McGraw-Hill India, 2017, New Delhi.
3. Robert D. Cook, Concepts and Applications of Finite Element Analysis, Wiley India, 4th edition, 2007, New Delhi
4. J.N. Reddy, Introduction to the Finite Element Method, McGraw-Hill India, 4th edition, 2018, New Delhi.
5. Bathe K. J., Finite Element Procedures, Prentice-Hall Inc., 2nd edition, 2016, New Jersey.
6. P. Seshu, Finite Element Analysis, Prentice Hall of India, 10th edition, 2012, New Delhi.

Web and Video link(s):

https://nptel.ac.in/courses/112106135; *NPTEL Video Lecture on* ***Introduction to Finite Element Method,*** *Professor of ME,* ***IIT Madras***

Course Articulation Matrix (CAM):		**U24ME703: FINITE ELEMENT METHODS**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME703.1**	2	2	2	2	-	-	-	-	1	1	1	2	2
CO2	**U24ME703.2**	2	2	2	2	-	-	-	-	1	1	1	2	2
CO3	**U24ME703.3**	2	2	2	2	-	-	-	-	1	1	1	2	2
CO4	**U24ME703.4**	2	2	2	2	-	-	-	-	1	1	1	2	2
U24ME703		2	2	2	2	-	-	-	-	1	1	1	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	**apply** finite element formulation to one-dimensional bar problems and convergence analysis.	SDG9	Industry, Innovation and Infrastructure	FEM formulation and analysis support the development of reliable engineering components and modern industrial infrastructure.
CO2	**evaluate** truss and beam problems to determine displacements, reactions, and stresses using FEM..	SDG11	Sustainable Cities and Communities	FEM analysis of trusses and beams improves the safety and stability of buildings, bridges, and transportation structures used in sustainable communities.
CO3	formulate CST, LST, and quadrilateral finite elements for two-dimensional elasticity and isoparametric problems.	SDG9	Industry, Innovation and Infrastructure	Two-dimensional FEM analysis helps in efficient structural design, industrial innovation, and infrastructure development.
CO4	**analyze** heat transfer, vibration, and elasticity problems using finite element methods	SDG7	Affordable and Clean Energy	FEM-based thermal and vibration analysis improves energy efficiency and performance of engineering systems used in sustainable technologies.

ADDITIVE MANUFACTURING

Class: B. Tech. VII – Semester		**Branch:** ME	
Course Code:	**U24ME704**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: classify the rapid prototyping and working principle & application of liquid base RP processes

CO2 : distinguish between solid and powder-based RP Systems

CO3: analyse the working principles of extrusion-based RP and Rapid Tooling

CO4: apply directed energy deposition AM Processes and its applications

UNIT-I	9 Hrs

Introduction Rapid Prototyping: Fundamentals of rapid prototyping (RP), advantages and limitations of RP, commonly used terms, classification of rapid prototyping system, rapid prototyping process chain.

Liquid-based Rapid Prototyping Systems: Stereolithography apparatus (SLA), Solid ground curing (SGC)-working principle, applications, advantages and disadvantages, vat photopolymerization-process benefits, drawbacks and applications.

UNIT-II	9 Hrs

Solid based Rapid Prototyping Systems: Laminated object manufacturing (LOM), Stratasys', Kira's Paper lamination technology (PLT)-working principle, applications, advantages and disadvantages, Shape deposition manufacturing process.

Powder Based Rapid Prototyping Systems: Selective laser sintering (SLS), Powder fusion mechanism and powder handling, Electron beam melting (EBM), Fraunhofer's Multiphase Jet Solidification, (MJS), Laser powder bed fusion (LPBF) -working principle, applications, advantages and disadvantages.

UNIT-III	9 Hrs

Extrusion-Based AM Processes: Fused deposition modelling (FDM), principles, materials, process modelling, plotting and path control, bio-extrusion, contour crafting, process benefits, drawbacks and applications of extrusion-based processes.

Rapid Tooling: Conventional tooling and rapid tooling, classification of rapid tooling, direct and indirect tooling methods, soft and hard tooling methods.

UNIT-IV	9 Hrs

Directed Energy Deposition AM Processes: Process description, material delivery, Laser engineered net shaping (LENS), Direct metal deposition (DMD), Wire arc additive manufacturing (WAAM), Process benefits, drawbacks and applications.

Rapid Prototyping Applications: Application-material relationship, applications in design, engineering, analysis and planning, aerospace industry, automotive industry, biomedical industry, jewellery industry and coin industry.

Textbook(s):

1. Chua Chee Kai., Leong Kah Fai. and Chu Sing Lim, *Rapid Prototyping: Principles and Applications in Manufacturing*, 2nd edn., World Scientific, 2003. (Chapters 1, 2, 3, 4, 5 & 7)

2. Ian Gibson., David W Rosen. and Brent Stucker., *Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing*, 1st edn., Springer, 2010. (Chapters 2 & 5, 6)

Reference Book(S):

1. D.T. Pham, Duc, S.S. Dimov, *Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling*, 1st edn. Springer 2001.
2. Rafiq Noorani, Rapid Prototyping: *Principles and Applications in Manufacturing*, 2nd edn., John Wiley & Sons, 2006.

Web and Video link(s):

https://onlinecourses.nptel.ac.in/noc22_ee116/preview; *NPTEL Video Lecture on Fundamentals of Additive Manufacturing Technologies by Prof. Prof. Sajan Kapil, Department of Mechanical Engineering IIT Guwahati.*

Course Articulation Matrix (CAM):		U24ME704 : ADDITIVE MANUFACTURING												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME704.1	2	1	2	1	-	1	-	-	1	-	1	1	2
CO2	U24ME704.2	2	1	2	1	-	1	-	-	1	-	1	1	2
CO3	U24ME704.3	2	1	2	1	-	1	-	-	1	-	1	1	2
CO4	U24ME704.4	2	1	2	1	-	1	-	-	1	-	1	1	2
U24ME704		2	1	2	1	-	1	-	-	1	-	1	1	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	classify the rapid prototyping and working principle & application of liquid base RP processes	SDG 9	Industry, Innovation, and Infrastructure	Liquid-based RP (Stereolithography) represents a leap in high-precision industrial innovation, allowing for complex geometries that optimize part performance and reduce material use.
CO2	distinguish between solid and powder-based RP Systems	SDG 12	Responsible Consumption and Production	Understanding different material states (solid vs. powder) allows students to select processes that minimize raw material waste and utilize recyclable thermoplastics or metal powders.
CO3	analyse the working principles of extrusion-based RP and Rapid Tooling	SDG 9 & SDG 12	Industry Innovation & Responsible Production	Rapid Tooling significantly shortens the product development cycle and reduces the energy footprint of manufacturing molds/dies compared to traditional heavy machining.
CO4	apply directed energy deposition AM Processes and its applications	SDG 9, SDG 12 & SDG 3	Industry Innovation & Responsible Production	AM and DED enable "Industry 4.0" by consolidating complicated parts and repairing high-value infrastructure, boosting industrial resilience. Transitioning from subtractive to additive methods reduces material waste and extends component life, supporting circular economy concepts. AM enhances patient outcomes and quality of life via bio-printing and patient-specific implants.

PRODUCTION AND OPERATIONS MANAGEMENT

Class: B. Tech. VII – Semester		**Branch:** ME	
Course Code:	**U24ME705**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : classify forecasting techniques and analyze inventory models by deriving EOQ for different inventory systems

CO2 : evaluate the components and functions of Production Planning and Control, including Material Requirement Planning and Aggregate Planning

CO3 : apply CPM, PERT, transportation, assignment, sequencing, and scheduling techniques to solve production and operations problems

CO4 : choose suitable work study and work measurement tools and techniques to improve productivity and determine standard time.

UNIT-I	**9 Hrs**

Production and Operations Management: Introduction, objectives and areas

Forecasting: Qualitative techniques-market survey, Delphi method and life cycle analogy; Quantitative techniques-time series methods, moving average, simple exponential smoothing and regression analysis; Forecasting errors

Inventory Control: Quantitative inventory- Economic Order Quantity (EOQ) for purchase model, manufacturing model and discount model; Qualitative inventory-classification and ABC analysis

UNIT-II	**9 Hrs**

Production Planning and Control: Objectives, components and functions

Material Requirement Planning: Terminology, system inputs and outputs, MRP logic.

Aggregate Planning: Characteristics, decision options- modification of demand and supply

UNIT-III	**9 Hrs**

Sequencing and Scheduling: sequencing of 'n' jobs on 1, 2 and 3 machine problems

Network Models: CPM and PERT**;** Transportation models and assignment models - Hungarian method.

UNIT-IV	**9 Hrs**

Work Study: Techniques of work study; method study-tools and techniques, process charts

Work Measurement: Elements of time study, time study procedure, standard time calculations.

Textbook(s):

1. Shailendra Kale, *Production and Operations Management*, McGraw-Hill, 2017, New Delhi.

Reference Book(S):

1. Panneerselvam, *Production and Operation Management*, New Delhi: PHI, 2017.
2. Joseph G. Monks *Operations Management: Theory and Problems*, 2nd ed. New York: McGraw-Hill, 1982.
3. Elwoods. Buffa, *Modern Production and Operations Management*, 8th ed. New Delhi: Wiley Eastern, 2009.
4. Hajra Chowdary, Production Management-Integrated with Industrial Engineering Approach, 2nd ed. Bombay: Media Promoters and Publishers, 1993.

Web and Video link(s):

https://nptel.ac.in/courses/110107141; *NPTEL Video Lecture on Production and Operation Management by Prof. Rajat Agrawal, Professor of Management Studies, IIT Roorkhee.*

Course Articulation Matrix (CAM):		U24ME705 : PRODUCTION AND OPERATIONS MANAGEMENT												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME705.1	2	2	1	-	1	1	-	-	1	-	1	2	1
CO2	U24ME705.2	2	2	1	-	1	1	-	-	1	-	1	2	1
CO3	U24ME705.3	2	2	1	-	1	1	-	-	1	2	1	2	1
CO4	U24ME705.4	2	2	1	-	1	1	-	-	1	-	1	2	1
U24ME705		**2**	**2**	**1**	**-**	**1**	**1**	**-**	**-**	**1**	**2**	**1**	**2**	**1**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	classify forecasting techniques and analyze inventory models by deriving EOQ for different inventory systems	SDG 12	Responsible Consumption and Production	Forecasting and inventory optimization improve industrial efficiency, reduce waste and support sustainable resource utilization.
CO2	evaluate the components and functions of Production Planning and Control, including Material Requirement Planning and Aggregate Planning	SDG 8	Decent Work and Economic Growth	Effective production planning enhances productivity, industrial growth and efficient utilization of manpower and materials.
CO3	apply CPM, PERT, transportation, assignment, sequencing and scheduling techniques to solve production and operations problems	SDG 11	Sustainable Cities and Communities	Optimization techniques improve industrial operations, transportation efficiency, project management and infrastructure sustainability.
CO4	apply work study and work measurement tools and techniques to improve productivity and determine standard time	SDG 8	Decent Work and Economic Growth	Work study and work measurement techniques improve productivity, optimize resource utilization, enhance workplace efficiency, and support sustainable industrial and economic growth.

FINITE ELEMENT METHODS LABORATORY

Class: B. Tech. VII – Semester		**Branch:** ME	
Course Code:	**U24ME706**	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : analyze bar of constant area, stepped bar, tapered bar & plane truss problems using computer aided analysis techniques

CO2 : examine stress distribution in structural components using FEM modeling and analysis.

CO3 : evaluate thermal and dynamic behaviour of engineering systems using finite element techniques.

CO4 : develop FEM programs for solving one-dimensional engineering problems.

Experiments

1. Static Analysis of Bars of Constant Cross-Section Area.
2. Static Analysis of Bars of tapered cross-sectional area and Stepped bar.
3. Static Analysis of Plane Truss Member.
4. Shear Force and Bending Moment diagrams of simply supported beams with point load, UDL, varying load.
5. Modeling and Stress Analysis of Rectangular plate with a circular hole (Plane stress).
6. Modeling and Stress Analysis of corner angle bracket
7. Modeling and Stress Analysis of circular pipe (Axi-symmetric).
8. Thermal Analysis –One-dimensional problem with conduction and convection boundary conditions for a fin.
9. Thermal Analysis - One-dimensional problem with conduction and convection boundary conditions for a composite slab.
10. Dynamic Analysis – Determination of Natural frequency for a cantilever beam.
11. Dynamic Analysis - Modal and Harmonic analysis for cantilever beam.
12. Develop a FEM1D program that applies the finite element method (FEM) to a linear two-point boundary value problem (BVP) in one spatial dimension.

Textbook(s):

1. Chandrupatla T. R. and Belegundu A. D., Introduction to Finite Elements in Engineering, 4th Edition, Prentice Hall India, 2012

Reference Book(S):

1. Singiresu S. Rao, *The Finite Element Method in Engineering*, 6th Edition, Butterworth–Heinemann (Elsevier), 2018.
2. David V. Hutton, *Fundamentals of Finite Element Analysis*, 1st Edition, McGraw–Hill, 2004.

3. Robert D. Cook, David S. Malkus, Michael E. Plesha and Robert J. Witt, *Concepts and Applications of Finite Element Analysis*, 4th Edition, John Wiley & Sons, 2002.
4. T. R. Chandrupatla, *Finite Element Analysis for Engineering and Technology*, 1st Edition, Universities Press, 2009.
5. P. Seshu, *Finite Element Analysis*, 10th edition, Prentice Hall of India, New Delhi, 2012.

Laboratory Manual (for laboratory component):

1. *Finite Element Methods Laboratory Manual, Dept. of ME, KITSW.*

Course Articulation Matrix (CAM):		U24ME706: FINITE ELEMENT METHODS LABORATORY												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME706.1	2	2	2	2	2	-	-	1	1	2	2	2	2
CO2	U24ME706.2	2	2	2	2	2	-	-	1	1	2	2	2	2
CO3	U24ME706.3	2	2	2	2	2	-	-	1	1	2	2	2	2
CO4	U24ME706.4	2	2	2	2	2	-	-	1	1	2	2	2	2
U24ME706		2	2	2	2	2	-	-	1	1	2	2	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	**apply** finite element methods to analyze bars, trusses, and beam problems.	SDG 9	Industry, Innovation and Infrastructure	Finite element analysis of structural members supports the design and development of reliable engineering structures and industrial systems.
CO2	examine stress distribution in structural components using FEM modeling and analysis.	SDG 11	Sustainable Cities and Communities	Stress analysis of engineering components helps in developing safe, durable, and sustainable structural systems for modern infrastructure.
CO3	evaluate thermal and dynamic behaviour of engineering systems using finite element techniques	SDG 7	Affordable and Clean Energy	Thermal and dynamic analysis improves the energy efficiency of thermal systems and enhances the performance and safety of engineering applications.
CO4	develop FEM programs for solving one-dimensional engineering problems.	SDG 9	Industry, Innovation and Infrastructure	FEM-based computational analysis and program development promote advanced engineering simulations and intelligent industrial solutions.

INTERNSHIP EVALUATION			
Class: B. Tech. VII – Semester		**Branch:** ME	
Course Code:	U24ME707	**Credits:**	**6**
Hours/Week (L-T-P- E):	**0-0-2-2**	**CIE:**	**100%**
Total Number of Teaching Hours:	**-**	**ESE:**	

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

CO1: Demonstrate understanding of professional practices, workplace ethics, and organizational functioning through internship experience

CO2: Apply engineering knowledge and modern tools to perform assigned tasks and solve real-world problems

CO3: Exhibit professional skills including communication, teamwork, leadership, and lifelong learning

CO4: Prepare internship reports and effectively communicate internship outcomes through presentations and viva-voce

Mandatory Internships:

1. The internships provide exposure to the real-world, get a feel for the work environment and how a professional workplace operates.
2. During the internship, students will experience a real-life engineering workplace and understand how their engineering and professional knowledge, skills, and qualities (KSQs) can be utilized in industry.
3. Students can learn, more importantly, how to apply the KSQs they have acquired during an internship to their future workplaces.
4. Students will also be able to demonstrate functioning engineering knowledge, both new & existing, and identify areas of further development for their future careers.
5. Internships give the student an opportunity to bridge theory and practice
6. Internships also provide students with the soft skills needed at workplace and leadership positions.
7. The internship guidelines are governed by the rules stipulated in the Institute's Internship Policy-2020 document.
8. The students shall have to undergo 6-8 weeks of mandatory internship during summer/winter vacation at industry/R&D organization / Academic Institutes like IITs, IIITs& NITs.
9. HoD, along with Prof i/c internships, shall address students (*of 2nd, 4th and 6th semesters*) during last week of even semester of every academic year on the following
    a. creating awareness on mandatory 6-8 weeks internship by every student
    b. creating awareness on COs of internships
    c. KSQs the students would acquire doing internships
    d. expected internship outcomes
    e. available internship options, and organizations offering internships
    f. progressively completing 6-8 weeks internship by the end of 6th semester summer, starting from 2nd semester summer break.
    g. internship evaluation in 7th semester
    h. internship report submission and oral presentation (through PPT) by student
10. Students undergoing the internship shall be required to submit their details to the department internship coordinators of the respective branches. He will coordinate all the internship activities of the students of that department.
11. Students have to submit a signed undertaking to the department internship coordinator for demonstrating honesty, integrity, professionalism and regular attendance at work place to add value to the organization where the internship is allotted. Students also have to uphold the professional image of our institute.
12. In case, a student is found to violate the internship rules and regulations, the student will have to produce a valid reason for the violation of internship rules. Without a valid reason, the student will be debarred from taking part in subsequent placement activities of the

institute.

13. The students preferably shall undergo internship at one organization only. In case of any difficulty, the stipulated period of internship shall be completed at different organizations with minimum of one week internship at every stage.
14. The internship evaluation shall be done in the VII semester of study and hence the students shall complete the prescribed period of internship before start of VII semester (from end of II semester to commencement of VII semester).
15. The student learning assessment process (SLAP): The SLAP in internships shall include feedback from internship supervisor, submission of internship report on the complete internship and PPT presentation.
16. Internship Log Book: The activity journaling in a log book is very important for a successful internship.
    a. The internship supervisor identifies the work goals at the beginning of the internship
    b. Student has to maintain internship log book, where in the activities undertaken during internship and timely submission at periodic intervals are to be documented.
    c. At the conclusion of the internship, the supervisor shall specifically comment, in the internship log book, on whether the student met each of the work goals and to give evidence which describes the quality of work. For student, this also serves as a self-assessment.
    d. Internship log book *(with due signatures of the internship supervisor)* shall be considered for evaluation during presentation, i.e., number of planned meetings with internship supervisor and number attended by student
17. Meeting Cadence:
    i. **Regular meetings with internship supervisor:** Regular meetings with the internship supervisor to discuss work goals and review the status of activities undertaken are very essential. Student shall participate in discussions and take notes.
    ii. **Meeting Frequency:** The meeting cadence, *i.e., meeting frequency* shall be fixed in consultation with the internship supervisor and accordingly student has to participate in discussions and take notes. Take signatures of internship supervisor as per the planned cadence in the internship log book.
18. The internship evaluation shall be done by ***department internship evaluation committee (*DIEC*)*** based on the submitted report by student and oral presentation.
19. There shall be only Continuous Internal Evaluation (CIE) for internship evaluation.
20. CIE for the Internship evaluation in VII semester shall be as below:

Internship evaluation	Weightage
A. **Internship Supervisor's Assessment** *(i) Feedback from the internship supervisor* *- on completion of internship assignment/work (20%)* *(ii) Feedback from the internship supervisor* *- on quality of work in internship assignment/work (10%)* *(iii) Feedback from the internship supervisor* *- internship log book (10%)* *(iv) Feedback from the internship supervisor* *- on attendance, punctuality and work hours (10%)* (For the case of 6-8 week internship done in more than one spell, it will be the average of all the internship supervisors' assessments)	**50%**
B. DIEC Assessment *(i) Internship duration (8 /12 weeks) (6/8 weeks online via NPTEL and 2/4 weeks offline) (10% / 10%)* *(ii) Internship Report (20%)* *(iii) Oral Presentation (with PPT) and viva voce (10%)* *(iv) SDG (5%)* *(v) Research Orientation (5%)*	**50%**
Total Weightage:	**100%**

Note: *It is mandatory for the student to appear for oral presentation (with PPT) and viva voce to qualify for course evaluation*

(a) Internship Report: Each student is required to submit a well-documented internship report (both *soft copy and softbound hard copy*) as per format specified by DIEC. In case of completing the 6-8 weeks internship in more than one organization, the student shall be required to prepare separate softbound internship reports signed by the internship supervisor (s)along with the seal(s) of the organization(s). The student shall submit two final softbound internship reports along with a soft copy, keeping all the certificate(s) issued by the internship supervisor(s) and all the individual internship reports cleared by the respective internship supervisor. Chapter 1 of the final internship report shall clearly describe the following, indicating an overall summary.

(i) **Internship(s) attended**: A table with name & address of organization, organization's vision and mission, internship weeks attended, internship period (exact dates attended), internship supervisor, head of the section and head of the organization.

(ii) **Duties/tasks during internship(s)**: Table describing name &address of organization, and the duties/tasks undertaken during internships. This indicates what opportunities and learning experiences the interns got to get hands-on experience on a wide range of KSQs of a professional engineer.

(iii) **Tangible outcomes of internship:** These are the lessons learnt from internship experience. The students have to describe in their own words what they learnt from the internship experience. The student has to describe what specific KSQs are acquired by him, with reference to the expected internship COs, after successful completion of internship(s). Finally, a table depicting systematic mapping of what they have learnt and the expected internship COs is to be shown.

(iv) Student feedback on internship: To gather information on whether the internship was useful and gave practical experience in the chosen field of interest, and other learning, a well-defined feedback questionnaire (*made available by the dept*)with closed and open questions shall be kept in the report.

(v) Pictures at the worksite: Student has to keep, in the report, his working pictures at the worksite, discussing with the internship supervisor, the creative project he is working on, or an event he is attending for work, group photo of the team/section/department he worked with.

(b) Anti-Plagiarism Check: The internship report should clear the plagiarism check as per the Anti-Plagiarism policy-2020 of the institute.

(c) Presentation: Each student should prepare PPT with informative slides and make an effective oral presentation before the DIEC as per the schedule notified by the department. The presentation shall compulsorily have slides on the points mentioned in (a)(i)-(v)

(d) It is mandatory for every student to *appear for oral presentation(with PPT) and viva-voce*, to qualify for internship evaluation

(e) A student shall register for supplementary examination for the internship evaluation in the following cases:

(i) absent for oral presentation and viva-voce
(ii) fails to submit the internship report in prescribed format
(iii) fails to fulfill the requirements of internship evaluation as per specified guidelines

(f) Supplementary examination for internship evaluation

(i) The CoE shall send the list of students registered for supplementary examination to the HoD concerned.
(ii) The DIEC, duly constituted by the HoD, shall conduct the internship evaluation supplementary exam and send the award list to the CoE within the stipulated time.

Course Articulation Matrix (CAM):		U24ME707: INTERNSHIP EVALUATION												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME707.1	1	-	-	-	-	-	1	3	-	-	-	-	-
CO2	U24ME707.2	3	2	1	1	3	-	1	-	-	-	-	2	2
CO3	U24ME707.3	-	-	-	-	-	-	1	1	3	3	2	-	-
CO4	U24ME707.4	-	-	-	-	-	-	1	-	1	3	-	-	-
U24ME707		2	2	1	1	3	-	1	2	2	3	2	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement (The student should be able to…)**	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Demonstrate understanding of professional practices, workplace ethics, and organizational functioning through internship experience	**SDG 4**	Quality Education	Industrial internship provides experiential learning in ECE domains such as Embedded Systems, IoT, VLSI, Communication Systems, Signal Processing, Artificial Intelligence, and Semiconductor Technologies. Students acquire practical skills, industry exposure, professional networking opportunities, and lifelong learning abilities, thereby strengthening quality technical education and employability.
CO2	Apply engineering knowledge and modern tools to perform assigned tasks and solve real-world problems	**SDG 11**	Sustainable Cities and Communities	Effective communication and collaboration are essential for multidisciplinary ECE projects such as smart city infrastructure, intelligent transportation systems, public safety networks, and digital communication platforms that contribute to sustainable and connected communities.
CO3	Exhibit professional skills including communication, teamwork, leadership, and lifelong learning	**SDG 9**	Industry, Innovation and Infrastructure	Application of ECE concepts to industrial problems through communication networks, embedded systems, IoT, VLSI, robotics, AI-enabled systems, and automation technologies promotes innovation, industrial modernization, and sustainable infrastructure development.
CO4	Prepare internship reports and effectively communicate internship outcomes through presentations and viva-voce	**SDG 12**	Responsible Consumption and Production	Professional ethics, quality assurance, responsible technology deployment, resource optimization, and sustainable engineering practices in ECE industries encourage responsible production, efficient use of resources, and continuous improvement.

MAJOR PROJECT PHASE 1			
Class: B. Tech. VII – Semester		**Branch:** ME	
Course Code:	U24ME708	**Credits:**	**1**
Hours/Week (L-T-P- E):	**0-0-8-8**	**CIE:**	**100%**
Total Number of Teaching Hours:	**-**	**ESE:**	**-**

Course Learning Outcomes (COs):
After completion of this course, the students should be able to,
(based on cognitive skills acquired from theory component)

CO1: review research literature, identify gaps in the literature, formulate problem, apply knowledge of mathematics, sciences, engineering fundamentals, experimental and data analysis techniques; synthesize technical knowledge and innovative approaches to generate suitable solutions for real- world complex engineering problems (**Technical skills**)

CO2: design a system or product based on product/customer specifications; develop, analyze, and critically evaluate the design alternatives in order to justify the solutions to a real-world problem guided by ethical, environmental, societal and sustainable development considerations; use modern engineering and IT tools to design, build and test a prototype within specified project timeline and budget (**Problem solving and critical thinking skills**)

CO3: apply project management and organizational skills; demonstrate integrity, leadership, creativity, professional and ethical responsibilities as an individual and as a member or leader to produce time-sensitive deliverables in a multi-disciplinary team (**Ethics and teamwork**)

CO4: collate the results, compare performance of prototype to design specifications and present clearly and effectively the proposed solution, conclusions and/or recommendations in written (report, poster, technical paper), oral (presentations) and multimedia formats (video pitch) and engage in self-directed independent learning and life-long learning demonstrating the KSQ of a professional engineer (**Communication skills and life-long learning**)

1. Final Year Major Project work represents the culmination of study towards the B. Tech degree. ***Major project offers an opportunity to integrate the knowledge acquired from various courses and apply it to solve real-world complex engineering problems***. The **student learning assessment process** (SLAP) shall include good number of presentations, demonstration of work undertaken, submission of a project report, writing project paper in scientific journal style & format, preparing project poster and creating video pitch on the complete project work.
2. Activities of major project SLAP shall be planned in such a way to ensure that the students acquire the essential knowledge, skills and qualities (KSQ) of a professional engineer.
3. **Team work:** Major project work is a team work.
   (i) The students of a project team shall work together to achieve a common objective.
   (ii) Every student of a project team is expected to function effectively as an individual, and also with others as a team member in an ecosystem of a team having knowledge diversity, gender diversity, social and cultural diversity among its members.
4. **Two phases:** Major project work shall be carried out in two phases. Nearly 50 - 75% of the proposed work to be completed in 7thsemester as *Phase-I* and the remaining work to be continued and completed in 8thsemester as *Phase-II.*
5. Every student is expected to put approximately **72 hours of work**intothemajorproject *phase-I* courseoverthe12weeksof7thsemester.

6. Majorprojectwork*Phase-I*:7thsemester

(i) The HoD shall constitute the ***department project evaluation committee (DPEC)***with following composition

Department project evaluation committee (DPEC)	
HoD	Chairman
Senior Faculty	Convener
Coordinator(s)	Section-wise coordinator(s) *One coordinator for each section*
Three Faculty members	Section-wise faculty members *Three faculty members for each section representing various specializations. (Five specializations will be covered including the coordinator's and Convener's)*

(ii) Major project allotment to students during last working week of 6thsemester:

(a) **First / Second week of 6thSemester**: The process shall be initiated during the first / second week of 6thsemester by collecting project titles from the department faculty research groups, on offering innovative ideas/solutions for engineering problems.

(b) **MSE-I period of 6th Semester – Notifying project titles**: The finalized project titles shall be notified to students during the MSE-I period of 6th semester and student teams shall be allowed to exercise their options on titles that interest them.

(c) **Last working week of 6th Semester – Allotment of titles and supervisors to project teams**: The project title allotment to major project teams shall be completed before the last day of instruction of 6th semester

(d) **6th semester summer break - Literature review**: This 6th semester schedule enables students to complete literature review, preliminary simulations / investigations / experimentation during 6th semester summer break and *start the work from day-one in 7thsemester*

(e) **Registration Presentation - Notifying the tentative dates:** The major project teams are expected to give registration presentation during second / third week from the commencement of 7th semester. The tentative dates for conducting the registration presentation shall be notified at the time of releasing the circular on allotted project title and project supervisors, as indicated in (c) above. This enables student teams to plan the work accordingly during summer break, to complete the literature review, preliminary simulations / investigations and get ready for informative, confident and comfortable presentations on their project work.

(iii) The convener DPEC shall notify, during MSE-I period of 6th semester, the list of implementable project titles offered by the faculty of different research groups of the department

(a) Project titles shall come with the following details to be made available to students on dept webpage and notice boards, facilitating students to select problems that interest them.

i. abstract
ii. deliverables / outcomes
iii. knowledge and skills required to complete the project
iv. resources required
v. one of the deliverables shall be writing a technical paper out of the major project work done for submission to a reputed non-predatory conference/non-paid peer reviewed journal

(iv) The major project teams, finalized by the convener DPEC, shall be allowed to exercise their options on the titles that interest them from the notified list

(v) **Project supervisor allotment**: The convener DPEC shall allot, during the last week of 6th semester, the faculty supervisors to all project teams

(a) The project supervisors shall

i. **define project objectives and expected deliverables**

ii. help the students plan their project work and timeline

iii. provide enough resources for successful project completion

(vi) The faculty supervisors are expected to provide guidance to project teams on

(a) *Knowledge, skills and qualities (KSQ) to be acquired* to propose solutions to the identified real-world problems

(b) *Problem analysis* - to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

(c) Applying engineering knowledge - to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

(d) *Design/development of solutions* - to design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental Considerations

(e) *Conduct investigations of complex problems* - to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

(f) *Modern tool usage* – to create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

(g) *The Engineering and the world* – to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

(h) *Ethics* – to apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice

(i) *Individual and team work* – to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

(j) *Communication* – to communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

(k) *Project management and finance* – to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

(l) *Life-long learning* – to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

(vii) The project supervisors are also expected to continuously emphasize and guide students on

(a) Meeting Cadence:

i. **Regular meetings with supervisor:** Short and frequent meetings increasea team's work momentum. Regular meetings with supervisor to review the status of project are very essential. All students of the team shall participate in discussions and take notes.

ii. **Meeting Frequency: Semi-weekly cadence,** i.e., the meeting frequency shall be **twice a week.** Due weightage will be given to meeting cadenceand considered for evaluation during presentations, i.e., number of planned meetings and number attended by students

(b) **Project Log Book:** The activity journaling in project log book is veryimportant for a successful project.

i. Project log book is a written record showing the daily project activity on project goals from the very first thing like starting the project (an introduction statement what the project is all about), to the completion of the work (including the final results, and whether project met the core objectives / outcomes, etc.).

ii. In project log book, the activities like regular meetings with project supervisor, and work carried out on daily/weekly basis are to be recorded. This ensures that the student progress is being monitored well.

iii. The project supervisor shall regularly check the log book of every student of project team and endorse each and every activity by affixing his signature with date. With this, the number of planned meetings and number attended by the students will be also monitored.

iv. Log books are to be shown during all presentations and will be graded along with the project.

v. At the conclusion of the project work *phase-I*, the supervisor shall specifically comment, in the project log book, on whether the project team met each of the project work *phase-I* goals and to give evidence which describes the quality of work. For project teams, this also serves as self-assessment.

(c) **Following project timeline**: completing the tasks as planned in project timeline

(d) The relevant knowledge, skills and qualities (**KSQ**) an engineering graduate should possess, which can be specially acquired by participating in major project work

(e) **Writing down whatever is done and making notes of whatever is read.** Writing down the procedures/models followed, designs made, experiments conducted, simulations carried out, intermediate results obtained, ***difficulties faced and how they were fixed*** are very important. This kind of documenting the whole process as we go with project implementation is a very effective way and will help preparing a well- documented report having original content. Note down and include information about all the resources that you used, magazines, Journals, patents, books, and so on.

This information will be needed for the bibliography in your project report. On the other hand, documenting a report ***on the spur of the moment*** would end up copying things from other sources resulting in a plagiarized document.

(f) **Good and sufficient literature review**: Literature review is a description and analysis of information related to the topic of project work. Reading good number of review articles, research articles published in recent issues of peer reviewed journals, technical magazines, patents, reference books on the topics of potential interest, will help one understand what has already been discovered and what questions remain to identify gaps in the literature.

(g) Completing nearly 50 - 75% of the proposed work during phase-I

(h) Right conduct of research to promote academic integrity, honesty and time management

(i) Preparing a well-documented report in proper format, covering the progress made during Phase-I

(j) Consequences of plagiarism and use of anti-plagiarism software to detect plagiarism in documents

(k) Submission of major project phase-I report within acceptable plagiarism levels, as per the ***Anti-plagiarism policy-2020 of our institute***.

(l) **Video pitch:** Capturing short videos, photos, screenshots on experiments conducted, simulations carried out, prototype / working model / process / software package / system developed during course of project execution, photos showing interaction with supervisor for creating a short video pitch on the work done during *phase-I.*

(m) **Project Paper**: Writing a technical paper at the end of *phase-II* based on the solution(s) proposed, results obtained, and prototype / working model / process / software package / system developed, for submission to a reputed non-predatory conference/non-paid peer reviewed journal.

(n) **Project poster**: At the end of phase-II, the project teams shall have to present their project in the form of posters, at the time of demonstration of complete porotype / working model / software package / system developed.

(viii) Phase **– I evaluation**: There shall be only Continuous Internal Evaluation (CIE) for major project work *phase-I* with following components

(a) **Registration Presentation** *(during second / third week of 7th semester):* The Registration Presentation shall include a brief report and presentation focusing the identified problem, objective(s), literature review, identifying research gap in the literature, implementation of existing methods, proposed solution, and expected outcome(s).

i. The registration presentation shall invariably include the **project plan timeline** with actual start and finish dates– monthly/weekly project milestones/ timeline prepared in MS Excel or any other project management tool.

ii. **Project timeline –** *Weekly project milestones*: It's a compact and creative way to present a project plan. Identify the project intermediate goals and related tasks for completing each of those goals. Categorize tasks for each week. In the project timeline use different colors to the tasks for each week. Horizontal timeline layouts shall be preferred or any other layout of team's choice.

iii. Project teams shall create and present the following during registration presentation
   1. *Complete project timeline*
   2. *Phase-I project timeline*
   3. *Phase-II project timeline*

iv. During every presentation, project teams shall compulsorily show the following as part of their presentation
   1. *The slides on project timeline and*
   2. *A table showing targeted tasks as per timeline and status – whether tasks accomplished?*

v. **Project log book**: Every student of the Project team shall compulsorily show the activity journaling in the log book (*with due signatures of project supervisor*) during presentations

(b) **Progress Presentation-I** *(during penultimate week of 7th semester):* At the end of first stage (7th semester), student teams shall be required present, before the DPEC, the progress made during phase-I and submit a well-documented report of work done for evaluation to the project coordinator

i. **Following project timeline**: The project timeline shall be meticulously followed and the tasks shall be completed as planned in the project timeline.

ii. Project teams shall compulsorily show the following as part of their progress presentation-I
   1. *The slides on project timeline and*

2. *A table showing targeted tasks as per timeline and whether tasks are accomplished?*

iii. **Project log book**: Every student of the Project team shall compulsorily show the activity journaling in the log book (*with due signatures of project supervisor*)

(c) **CIE schedule**: The convener DPEC shall release the complete schedule of CIE before start of 7th semester well in advance, so that student teams will complete the scheduled works and get ready with an informative, confident, and comfortable presentation for registration and progress presentations.

(ix) CIE for the Major project work Phase-I shall be as given below:

Major project work Phase-I Assessment *(7th semester)*	**Weightage**
A. Supervisor Assessment	**20%**
B. DPEC Assessment *(i) Registration Presentation (10%)* *(ii) Progress Presentation-I (20%)* *(iii) Project progress*: Part of working model/ process/software package/system developed (30%)* *(iii) Well-documented Progress Report on Phase-I work (10%)* *(iv) Video pitch on Phase-I (10%)*	**80%**
Total Weightage	**100 %**

* *Students are advised to complete major part of the project in phase-I only*

(a) **Working Model:** Every project team shall be required to develop a working model/ process/software package/system, on the chosen work. The progress made in this shall be demonstrated during progress presentation-I at the end of *phase-I* and the completed working model/ process/software package/system before the DPEC as per the dates specified by DPEC at the end of *phase-II*.

(b) **Progress Report on *phase-I*:** Every project team shall be required to submit a well-documented progress report on dissertation phase-I as per format specified by DPEC.

a. **Tangible outcomes of *phase-I* in Conclusions - Chapter:** These are thelessons learnt from doing a project work. The students have to describe in their own words what they learnt from the *phase-I* project work experience. They have to describe what specific KSQs are acquired by them, with reference to the expected COs, after successful completion of *phase-I* work. Finally, a table depicting systematic mapping of what they have learnt and the expected major project work COs, is to be presented in the conclusions chapter of *phase-I* report

(c) **Video pitch on *phase-I*:** Every project team shall be required to create a pitch video, which is a video presentation on their major project work *phase-I*. The project team shall present the produced video pitch during progress presentation-I. The produced video pitch should

a. be 3 to 5-minute-long video (no longer than 5 minutes)
b. be concise and to the point, on the problem and proposed solution
c. show project timeline and sample page of log book
d. highlight the progress made at various stages during *phase-I* project implementation with the help of short videos/photos / screenshots on experiments conducted, simulations carried out, part of prototype/ working model/process / software package/system being under development as part of proposed solution and also photos showing team interactions with supervisor and the team working in the lab on project
e. discuss the impact of proposed solution in *ethical, environmental, societal and sustainable development contexts.*
f. emphasize key points about *business idea, potential market for the proposed solution*

(x) It is mandatory for

(a) every student of the team to *appear for oral presentation and viva-voce*, as part of progress presentation -I to qualify for course evaluation

(b) every project team *to submit a well-documented progress report on major project work phase-I*, as part of progress presentation -I to qualify for course evaluation

(c) every project team to create and present a good video pitch on major project work *phase-I*, as part of progress presentation -I to qualify for course evaluation

(xi) A student shall register for supplementary examination for the Major project work *phase-I* in the following cases:

(a) He/she is absent for oral presentation and viva-voce as part of progress presentation-I

(b) The project team fails to submit the progress report on *Phase-I* in prescribed format

(c) The project team fails to submit the video pitch on the progress made during the *phase-I* period.

(d) he/she fails to fulfill the requirements of Major project work *phase-I* evaluation as per specified guidelines

(xii) Supplementary examination for Major project work *phase-I*

(a) The CoE shall send the list of students registered for supplementary examination to the HoDs concerned

(b) The DPEC, duly constituted by the HoD, shall conduct Major Project Phase I supplementary exam and send the award list to the CoE within the stipulated time

Course Articulation Matrix (CAM):		**U24ME708: MAJOR PROJECT PHASE I**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	U24ME708.1	3	3	2	3	2	1	1	1	1	1	2	2	2
CO2	U24ME708.2	3	3	3	2	3	3	2	1	1	2	2	2	2
CO3	U24ME708.3	1	1	1	1	1	2	3	3	2	3	1	-	-
CO4	U24ME708.4	1	1	1	2	2	1	2	1	3	1	3	-	-
U24ME708		2	**2**	**1.75**	**2**	**2**	**1.75**	**2**	**1.5**	**1.75**	**175**	**2**	**2**	**2**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement (The student should be able to…)**	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	review research literature, identify gaps in the literature, formulate problem, apply knowledge of mathematics, sciences, engineering fundamentals, experimental and data analysis techniques; synthesize technical knowledge and innovative approaches to generate suitable solutions for real-world complex engineering problems (Technical skills)	**SDG 9**	Industry, Innovation and Infrastructure	Research gap identification, problem formulation, and development of innovative engineering solutions promote technological advancement, industrial innovation, and sustainable infrastructure development in ECE domains such as communication systems, IoT, VLSI, AI, and embedded systems.

CO–SDG Alignment Matrix				
CO	**CO Statement (The student should be able to…)**	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO2	design a system or product based on product/customer specifications; develop, analyze, and critically evaluate the design alternatives in order to justify the solutions to a real-world problem guided by ethical, environmental, societal and sustainable development considerations; use modern engineering and IT tools to design, build and test a prototype within specified project timeline and budget (Problem solving and critical thinking skills)	**SDG 12**	Responsible Consumption and Production	Engineering design considering resource optimization, environmental impact, sustainability, and efficient utilization of technology promotes responsible production and sustainable engineering practices.
CO3	Apply project management and organizational skills; demonstrate integrity, leadership, creativity, professional and ethical responsibilities as an individual and as a member or leader of a multidisciplinary team.	**SDG 11**	Sustainable Cities and Communities	Effective teamwork, ethical engineering practices, leadership, and multidisciplinary collaboration facilitate the development of sustainable technological solutions that improve societal well-being and community infrastructure.
		SDG3	Good Health and Well-Being	ECE projects related to biomedical instrumentation, healthcare IoT, telemedicine, wearable sensors, and assistive technologies contribute to improved healthcare services and quality of life.
CO4	Collate results, compare prototype performance with specifications, communicate findings through reports, posters, technical papers, presentations, and video pitches; engage in self-directed and lifelong learning.	**SDG 4**	Quality Education	Technical communication, dissemination of knowledge, professional documentation, and lifelong learning foster continuous education, skill enhancement, and knowledge sharing among engineering professionals.

VIII SEMESTER

Sl. No.	Category	Course Code	Course Title	Lectures / week				Credits
				L	T	P	E	C
1	PEC	U24ME801	Program Elective - II / MOOCs-II	2	1	-	3	3
2	PEC	U24ME802	Program Elective - III / MOOCs-III	2	1	-	3	3
3	PEC	U24ME803	Program Elective - IV / MOOCs-IV	2	1	-	3	3
4	ELC	U24ME804	Major Project, Phase – 2 / Industrial Internship - 2	-	-	12	12	6
Total:				**6**	**3**	**12**	**21**	**15**
Additional Learning@:Maximum credits allowed for Honors/Minor				**-**	**-**	**-**	**-**	**04**
Total credits for Honors/Minor students:				**-**	**-**	**-**	**-**	**19**

#MULTIDISCIPLINARY OPEN ELECTIVES: Student has to select one course as multidisciplinary open elective from any of the MOPEC Basket of courses offered by other departments.

@ List of courses for additional learning through MOOCs towards Honors/Minor in Engineering shall be prescribed by the department under Honors/ Minor Curricula

B. Tech Honors with Research
Students opting for B. Tech Honors with Research shall Publish a research paper in reputed journal indexed by SCI / SCOPUS/Web of Science (4 Credits).

Program Elective – II/ MOOCs-II		
Sr. No.	**Course Code**	**Course Title**
1.	U24ME801A	Power Plant Engineering
2.	U24ME801B	Robotics
3.	U24ME801C	Digital Manufacturing
4.	U24ME801D	Jet Propulsion and Rocket Engineering
5.	U24ME801E	Any other course approved by BoS Chair and Dean AA
Program Elective - III/ MOOCs-III		
Sr. No.	**Course Code**	**Course Title**
1.	U24ME802A	Electric and Hybrid Vehicles
2.	U24ME802B	Composite Materials
3.	U24ME802C	Computer Integrated Manufacturing Systems
4.	U24ME802D	Geometrical Dimensioning and Tolerancing
5.	U24ME802E	Any other course approved by BoS Chair and Dean AA
Program Elective - IV/ MOOCs-IV		
Sr. No.	**Course Code**	**Course Title**
1.	U24ME803A	Energy Audit and Management
2.	U24ME803B	Product Design
3.	U24ME803C	Sustainability in Manufacturing
4.	U24ME803D	Industrial Management
5.	U24ME803E	Any other course approved by BoS Chair and Dean AA

POWER PLANT ENGINEERING			
Class: B. Tech. VIII–Semester		**Branch:** ME	
Course Code:	**U24ME801A**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from the theory component)

CO1: analyze the working principles of a nuclear power plant and waste disposal

CO2 : illustrate the working of steam and combined cycle power plants

CO3: assess the hydrology and examine the hydroelectric power plants

CO4: evaluate the power plant economic parameters

UNIT-I	9 Hrs

Energy Resources: Classification, present scenario in modern power plants, types of power plants, power potentiality in India

Nuclear Power Plants: Indian nuclear power stations, site selection, principle of nuclear fission, fuels, components of reactor; properties of coolants and moderators; types of reactors - boiling water, pressurized water, gas cooled, breeder and liquid metal cooled; types and disposal of nuclear waste; comparison between nuclear and thermal power plants

UNIT-II	9 Hrs

Steam Power Plants: Classification, site selection, modern power plant layout and system components; fuel handling, burning-over feed and under feed stokers, pulverized fuel and its advantages, air circulation, water treatment, cooling towers, principle of fluidized bed combustion and its advantages, ash handling and dust collection

Combined Cycle Power Plants: Topping cycle, bottoming cycle, gas and steam turbine combined cycle power plant-working principle, layout, advantages, limitations; Heat Recovery Steam Generator (HRSG)

UNIT-III	9 Hrs

Hydrology: Hydro-cycle, rain fall, run-off and its measurements, flow duration curves, mass curves and storage, hydrograph

Hydel Power Plants: Site selection, advantages of hydel plants over thermal plants, classification - high, medium and low head plants, runoff river plants, storage reservoir and pumped storage plants

UNIT-IV	9 Hrs

Power Plant Economics: Introduction, load curves, demand, load, diversity and plant capacity factor; elements of costs of power, fixed and operating costs, depreciation methods; selection of power generation method; input and output curves; economical load division; tariff methods for electrical energy

Textbook:

1. S. C. Arora & S. Domakundwar, *A Course in Power Plant Engineering*, Dhanpat Rai & Sons, 3rd ed. New Delhi: 2013.

Reference Book(s):

1. WakilM. M. El., *Power Plant Technology*, McGraw-Hill, New York, 1988.
2. Nag P.K., *Power Plant Engineering*, Tata McGraw-Hill, New Delhi, 2002.
3. Nagpal G.R., *Power Plant Engineering*, Khanna Publishers, New Delhi, 1988.
4. R.K Rajput, *Power plant Engineering*, Laxmi publication PVT LTD, 5th edition, New Delhi, 2007.

Web and Video link(s):

1. *https://nptel.ac.in/courses/112107291 NPTEL Video Lecture on Power Plant Engineering by Prof. Ravi Kumar, Professor of Mechanical Engineering, IIT Roorkee.*
2. *https://nptel.ac.in/courses/112103421 NPTEL Video Lecture on Power Plant System Engineering by Prof. Niranjan Sahoo, Professor of Mechanical Engineering, IIT Guwahati.*

Course Articulation Matrix (CAM):		**U24ME801A: POWER PLANT ENGINEERING**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME801A.1**	2	-	1	-	-	1	-	-	1	-	1	1	1
CO2	**U24ME801A.2**	2	-	1	-	-	1	-	-	1	-	1	1	1
CO3	**U24ME801A.3**	2	2	1	-	-	1	-	-	1	-	1	1	1
CO4	**U24ME801A.4**	2	2	1	-	-	1	-	-	1	-	1	1	1
U24ME801A		2	2	1	-	-	1	-	-	1	-	1	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	analyze the working principles of a nuclear power plant and waste disposal	SDG7	Affordable and Clean Energy	Nuclear power plants provide large-scale low-carbon electricity generation, contributing to clean and sustainable energy production while emphasizing safe waste disposal practices.
CO2	illustrate the working of steam and combined cycle power plants	SDG7	Affordable and Clean Energy	Steam and combined cycle power plants improve energy efficiency and support reliable electricity generation for sustainable development.
CO3	assess the hydrology and examine the hydroelectric power plants	SDG6	Clean Water and Sanitation	Hydrology and hydroelectric systems focus on water resource utilization and management, supporting sustainable use of freshwater resources.
CO4	evaluate the power plant economic parameters	SDG8	Decent Work and Economic Growth	Evaluation of economic parameters in power plants promotes cost-effective energy production, industrial productivity, and sustainable economic growth.

ROBOTICS

Class: B. Tech. VIII – Semester		**Branch:** ME	
Course Code:	**U24ME801B**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: classify the various drives and control systems for robots based on their operating principles

CO2: analyse the motion of the manipulator using direct kinematics and DH representation

CO3: design trajectory planning methods and control techniques for robots

CO4: evaluate the performance of sensors used for robot vision and sensing applications

UNIT-I	**9 Hrs**

Basic concepts in robotics: Classification of robots, advantages and applications of robots, different joints-revolute joint, prismatic joint etc, degrees of freedom of a manipulator for positioning & orientation, dexterous work space, reachable work space, basic components of a robotic system, factors affecting accuracy and repeatability of a manipulator, controller resolution, dexterity & compactness, Drives and control systems for robots.

UNIT-II	**9 Hrs**

Robot arm kinematics: Direct kinematics, position & orientation of a manipulator, representation of orientation in terms of unit vectors, successive rotations, rotations about two distinct moving axes, rotations about three distinct moving axes, transformation matrix for rotations, combined rotations, transformation between co-ordinate systems, Denavit - Hartenberg representation.

UNIT-III	**9 Hrs**

Trajectory planning: General considerations in trajectory planning, joint interpolated trajectories, planning of Cartesian path trajectories.

Control of robot manipulators: Control of robot arm, computed torque technique, feedback control, resolved motion control, adaptive control.

UNIT-IV	**9 Hrs**

Robot vision and sensing: Different types of sensors, proximity, touch, force and torque sensors, low-level and high-level vision, vision systems.

Textbook(s):

1. K.S. Fu, R.C. Gonzalez, C.S.G. Lee, *Robotics*, McGraw Hill, reprint 12th edition, 2016, New Delhi.

Reference Book(S):

1. Y. Koren, *Robotics for Engineers,* McGraw Hill, 5th edition, 1985., New York.
2. J.J. Craig, *Robotics,* Addison-Wesley, 1986, New Delhi.

Web and Video link(s):

https://onlinecourses.nptel.ac.in/noc22_ee116/preview; *NPTEL Video Lecture on Robotics by Prof. Dilip Kumar Pratihar, Professor of ME, IIT Kharagpur.*

Course Articulation Matrix (CAM):		U24ME801B: ROBOTICS												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME801B.1	2	1	1	-	1	1	-	-	-	-	1	2	1
CO2	U24ME801B.2	3	3	2	1	2	1	-	-	-	-	1	3	2
CO3	U24ME801B.3	2	2	3	1	2	1	-	-	-	-	1	2	3
CO4	U24ME801B.4	2	2	1	2	3	1	-	-	-	-	1	2	2
U24ME801B		2	2	2	1	2	1	-	-	-	-	1	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	classify the various drives and control systems for robots based on their operating principles	**SDG 9**	Industry, Innovation and Infrastructure	Knowledge of robotic drives and control systems supports the development of advanced industrial automation and innovative manufacturing infrastructure.
CO2	analyse the motion of the manipulator using direct kinematics and dh representation	SDG 4	Quality Education	Analytical understanding of robot kinematics enhances technical competency, problem-solving ability, and higher-order engineering skills among students.
CO3	design trajectory planning methods and control techniques for robots	SDG 9	Industry, Innovation and Infrastructure	Trajectory planning and robot control techniques contribute to efficient, precise, and intelligent automation systems used in modern industries.
CO4	evaluate the performance of sensors used for robot vision and sensing applications	SDG 8	Decent Work and Economic Growth	Understanding robot vision and sensing technologies promotes skill development in emerging automation sectors, supporting employability and productivity growth.

DIGITAL MANUFACTURING

Class: B. Tech. VIII – Semester		**Branch:** ME	
Course Code:	**U24ME801C**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1: analyse the fundamental theories of virtual prototyping and reverse engineering, and implement their applications in product development

CO2 : apply geometric modeling and reasoning techniques to manufacturing computing problems

CO3: analyse key implementation technologies including CAx integration, digital equipment processing, and maintenance diagnosis

CO4: evaluate the impact of transformative technologies such as Digital Twins, IoT-enabled supply chains, and blockchain on modern business operations

UNIT-I	**9 Hrs**

Digital Manufacturing: Introduction- Concepts and research and development status of digital manufacturing**, d**efinition; Operation mode and architecture;

Virtual prototyping- Basic Theory of virtual prototyping, application-Product representation and modeling, Human–machine interaction, Simulation and analysis; **Reverse Engineering**- Introduction, basic theory of Reverse Engineering-Data measurement theory, Data processing theory, Model reconstruction theory.

UNIT-II	**9 Hrs**

Geometric Modeling and Reasoning Manufacturing Computing: Theoretical Foundation, Geometric modeling forms, geometric modeling in manufacturing computing, Design and manufacture, Machining process simulation geometric reasoning.

Intelligent Manufacturing: Concept of intelligent multi-information sensing, applications, data mining methods, applications-Sensor Applications of Tool Condition Monitoring, Intelligent Multi Information Fusion-Basic principles, Configuration, Process, Tool State Monitoring;

Data Mining-Comparison Between Data Mining and Information Fusion, Data Mining Methods, Fault diagnosis data mining methods modeling, Data mining method of digital marketing.

UNIT-III	**9 Hrs**

Bionic Manufacturing: Basic principles, Bionic Structure, Bionic-Information, Bionic in Control, major progress, development trends-The Biological Surface Bionic Engineering, applications-Bionic Robot, The Micro Air Vehicle.

Biological Manufacturing-Research**,** Features and functions, implementation technology, Material Formability, The Accumulation and Assembly of Cells; Some Frontier Issues-Tissue-Like Precursor, Prosthesis and Tissue Engineering Scaffold.

Engineering Scaffold

Key Technology: CAx technology integration-CAD/CAE/CAPP/CAM, digital equipment, Digitized modeling, networking, digital processing technology-process, maintenance and diagnosis-Remote Failure Diagnosis Based on Network.

UNIT-IV	**9 Hrs**

Manufacturing as a Digital Business: The digital manufacturing ecosystem, components of a digital manufacturing business, the drivers of digital transformation, globalization and international expansion, regulatory pressure and compliance, standardization, consolidation and modernization, digital consumers.

New Product Design and Engineering: Digital twins, plant maintenance and asset management, aftermarket services and support; The Digital Supply Chain-an IoT-enabled supply chain, the AI and analytics infused supply chain, blockchain technologies.

Textbook(s):

1. Zhou, Zude., Xie, Shane (Shengquan). and Chen, Dejun, *Fundamentals of Digital Manufacturing Science*, 1st edn., Springer, 2012. (*Chapter 1, 2, 3, 5, 6 and 8)*
2. Barrenechea, Mark J. and Jenkins, Tom, *Digital Manufacturing*, 1st edn., Open Text Corporation, 2018. (*Chapter 2, 3 & 4)*

Reference Book(S):

1. Vinesh Raja and Kiran J Fernandes, *Reverse Engineering- An Industrial Perspective*, Springer-Verlag, 2008.
2. Gibson, Ian., Rosen, David., Stucker, Brent. and Khorasani, Mahyar, *Additive Manufacturing Technologies*, 3rd edn., Springer Cham, 2021.

Web and Video link(s):

1. https://onlinecourses.nptel.ac.in/noc24_mg116/preview. NPTEL Video Lecture on Industry 4.0: Managing the Digital Transformation by Prof. Murli Dhar Agrawal, Department of Management Science and Research, IIT Bombay.
2. https://onlinecourses.nptel.ac.in/noc24_me131/preview. NPTEL Video Lecture on Rapid Manufacturing by Prof. Janakarajan Ramkumar and Prof. Amandeep Singh Oberoi, Department of Mechanical Engineering, IIT Kanpur.

Course Articulation Matrix (CAM):		**U24ME801C: DIGITAL MANUFACTURING**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME801C.1**	2	2	1	-	1	1	-	-	1	-	1	1	2
CO2	**U24ME801C.2**	2	2	1	-	1	1	-	-	1	-	1	1	2
CO3	**U24ME801C.3**	2	2	1	-	1	1	-	-	1	-	1	1	2
CO4	**U24ME801C.4**	2	2	1	-	1	1	-	-	1	-	1	1	2
U24ME704.		2	2	1	-	1	1	-	-	1	-	1	1	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Analyse the fundamental theories of virtual prototyping and reverse engineering, and implement their applications in product development	SDG 9	Industry, Innovation, and Infrastructure	Virtual prototyping reduces the need for physical resources during R&D, fostering sustainable industrialization and innovation through "digital-first" development.
CO2	Apply geometric modeling and reasoning techniques to manufacturing computing problems	SDG 4 & SDG 9	Quality Education & Industry Innovation	1. Equips students with advanced computational skills and "Industry 4.0" literacy 2. bridging the gap between technical education and modern industrial requirements.
CO3	Analyse key implementation technologies including CAx integration, digital equipment processing, and maintenance diagnosis	SDG 12	Responsible Consumption	Bionic manufacturing promotes resource efficiency by mimicking nature
CO4	Evaluate the impact of transformative technologies such as Digital Twins, IoT-enabled supply chains, and blockchain on modern business operations	SDG 9 & SDG 12	Innovation & Responsible Production	Technologies like Digital Twins and IoT enable real-time energy monitoring and waste reduction, while Blockchain ensures transparency and ethical sourcing in global supply chains.

JET PROPULSION AND ROCKET ENGINEERING			
Class: B. Tech. VIII – Semester		**Branch:** ME	
Course Code:	**U24ME801D**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : analyze the performance and operating principles of turbojet, air-breathing, and rocket propulsion systems.

CO2 : compare solid propellant formulations, manufacturing methods, and combustion characteristics used in rocket propulsion.

CO3 : evaluate the design, combustion behavior, and performance of solid and liquid rocket propulsion systems, including internal ballistics and feed systems.

CO4 : analyze the operating principles, intake performance, combustion characteristics, and efficiency of ramjet and integral rocket ramjet propulsion systems.

UNIT-I	9 Hrs

Turbo Jet Propulsion System: Gas turbine cycle analysis – layout of turbo jet engine. Turbo machinery- compressors and turbines, combustor, blade aerodynamics, engine off design performance analysis.

Principles of Jet Propulsion And Rocketry: Fundamentals of jet propulsion, Rockets and air breathing jet engines – Classification – turbo jet , turbo fan, turbo prop, rocket (Solid and Liquid propellant rockets) and Ramjet engines.

UNIT-II	9 Hrs

Solid Propulsion System: Solid propellants – classification, homogeneous and heterogeneous propellants, double base propellant compositions and manufacturing methods.

Composite propellant: Composite propellant oxidizers and binders. Effect of binder on propellant properties. Burning rate and burning rate laws, factors influencing the burning rate, methods of determining burning rates.

UNIT-III	9 Hrs

Solid propellant rocket engine – internal ballistics, equilibrium motor operation and equilibrium pressure to various parameters. Transient and pseudo equilibrium operation, end burning and burning grains, grain design. Rocket motor hard ware design. Heat transfer considerations in solid rocket motor design. Ignition system, simple pyro devices.

Liquid Rocket Propulsion System: Liquid propellants – classification, Mono and Bi propellants, Cryogenic and storage propellants. Liquid propellant rocket engine system layout, pump and pressure feed systems, feed system components.

UNIT-IV	9 Hrs

Ramjet And Integral Rocket Ramjet Propulsion System: Fuel rich solid propellants, gross thrust, gross thrust coefficient, combustion efficiency of ramjet engine, air intakes and their classification – critical, super critical and sub-critical operation of air intakes, engine intake matching, classification and comparison of **Integrated Rocket-Ramjet** (IIRR)propulsion system propulsion systems.

Textbook(s):

1. Rocket Propulsion Elements GEORGE P. Sutton and OSCAR BIBLARZ ,Wiley India Pvt. Ltd. (Seventh Edition)

Reference Book(S):

1. Mechanics and Dynamics of Propulsion/ Hill and Peterson/John Wiley & Sons
2. Rocket propulsion elements/Sutton/John Wiley & Sons/8th Edition
3. Gas Turbines/Ganesan /TMH

4. Gas Turbines & Propulsive Systems/Khajuria & Dubey/Dhanpat Rai & Sons
5. Rocket propulsion/Bevere/
6. Jet propulsion /Nicholas Cumpsty/
7. Elements of Gas Turbine Propulsion/Jack D. Mattingly/TMH
8. Turbines, Compressors and Fans/S M Yahya /MGH

Web and Video link(s):

1. NPTEL : NOC:Introduction to Rocket Propulsion (Aerospace Engineering)
2. nptel.ac.in/courses/112106073

Course Articulation Matrix (CAM):		U24ME801D JET PROPULSION AND ROCKET ENGINEERING												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME801D.1	2	2	1	1	-	1	1	-	1	-	1	1	1
CO2	U24ME801D.2	2	2	1	-	-	1	1	-	1	-	1	1	1
CO3	U24ME801D.3	2	2	1	1	-	1	1	-	1	-	1	1	1
CO4	U24ME801D.4	2	2	1	-	-	1	1	-	1	-	1	1	1
U24ME801D		2	2	1	1	-	1	1	-	1	-	1	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	analyze the performance and operating principles of turbojet, air-breathing, and rocket propulsion systems.	SDG9	Industry, Innovation and Infrastructure	Promotes innovation and technological advancement in aerospace propulsion systems and transportation infrastructure.
		SDG7	Affordable and Clean Energy	Encourages efficient energy utilization and improved propulsion technologies for sustainable energy use.
CO2	compare solid propellant formulations, manufacturing methods, and combustion characteristics used in rocket propulsion.	SDG9	Industry, Innovation and Infrastructure	Supports research and development of advanced propulsion materials and manufacturing technologies.
		SDG12	Responsible Consumption and Production	Encourages efficient material utilization and sustainable manufacturing practices in propulsion systems.
CO3	evaluate the design, combustion behavior, and performance of solid and liquid rocket propulsion systems, including internal ballistics and feed systems.	SDG9	Industry, Innovation and Infrastructure	Enhances engineering design and innovation in high-performance aerospace propulsion technologies.
		SDG13	Climate Action	Promotes development of efficient propulsion systems aimed at minimizing environmental impact and improving energy efficiency.
CO4	analyze the operating principles, intake performance, combustion characteristics, and efficiency of ramjet and integral rocket ramjet propulsion systems.	SDG9	Industry, Innovation and Infrastructure	Encourages innovation in advanced high-speed propulsion technologies for aerospace applications.
		SDG13	Climate Action	Supports efficient propulsion technologies that contribute toward sustainable aerospace advancements and reduced emissions.

ELECTRIC AND HYBRID VEHICLES			
Class: B. Tech. VIII–Semester		**Branch:** ME	
Course Code:	**U24ME802A**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,
(based on cognitive skills acquired from the theory component)

CO1: analyze electric and hybrid vehicle characteristics

CO2 : distinguish configuration and controlling mechanism of hybrid and electric drive trains

CO3: analyze various energy storage technologies and evaluate hybridization strategies

CO4: compare energy management strategies and analyse case studies on Hybrid Electric Vehicle and Battery Electric Vehicle

UNIT-I	9 Hrs

Conventional Vehicles: Basics of vehicle performance, vehicle power source characterization, transmission characteristics, mathematical models to describe vehicle performance

Hybrid Electric Vehicles: History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies; Hybrid Electric Drive-Trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis

UNIT-II	9 Hrs

Electric Trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis

Electric Propulsion Unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of induction motor drives, configuration and control of permanent magnet motor drives, Configuration and control of switch reluctance rotor drives, drive system efficiency

UNIT-III	9 Hrs

Energy Storage: Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis

Hybridization: Hybridization of different energy storage devices; Sizing the drive system; Matching the electric machine and the internal combustion engine, sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, communications, supporting subsystems

UNIT-IV	9 Hrs

Energy Management Strategies: Energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies

Case Studies: Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV)

Textbook(s):

1. C. Mi, M. A. Masrur and D. W. Gao, "*Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives*", John Wiley & Sons, 2011.

Reference Book(s):

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.
2. Ali Emadi, Advanced electric drive vehicles CRC Press, Tylor and Francis Group ,2015.
3. Iqbal Hussein, Electric and Hybrid Vehicles: Design and fundamentals, CRC Press, 2003. 2nd edn.,
4. James Larminie, Electric Vehicle Technology Explained John Lowry Wiley, 2003.
5. K.C.Jain Dr.Amit R.Patil, Dr. Arvind J. Bhosale Dr. S.S. Raghuvanshi " Fundamentals of Hybrid and Electric Vehicles Khanna Publishers first edition

Web and Video link(s):

1. *https://nptel.ac.in/courses/108106170 NPTEL Video Lecture on Fundamentals of Electric vehicles: Technology & Economics, Professor of Electrical Engineering, IIT Madras.*
2. *https://nptel.ac.in/courses/108103009 Web notes on Introduction to Hybrid and Electric Vehicles by Prof. S. Majhi & Prof. Praveen Kumar, Professor of Electronics and Electrical Engineering, IIT Guwahati.*

Course Articulation Matrix (CAM):		**U24ME802A: ELECTRIC AND HYBRID VEHICLES**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME802A.1**	2	2	1	1	-	1	1	-	1	-	1	1	1
CO2	**U24ME802A.2**	2	2	1	-	-	1	1	-	1	-	1	1	1
CO3	**U24ME802A.3**	2	2	1	1	-	1	1	-	1	-	1	1	1
CO4	**U24ME802A.4**	2	2	1	-	-	1	1	-	1	-	1	1	1
U24ME802A		2	2	1	1	-	1	1	-	1	-	1	1	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	analyze the convectional vehicles and electric and hybrid vehicles	SDG11	Sustainable Cities and Communities	Electric and hybrid vehicles help reduce air pollution and promote sustainable transportation systems in urban areas.
CO2	explain the configuration and propulsion units of hybrid and electric drive trains	SDG7	Affordable and Clean Energy	Hybrid and electric drivetrains improve energy efficiency and encourage the use of cleaner energy technologies in transportation.
CO3	study on types of electric machines and energy storage devices	SDG9	Industry, Innovation and Infrastructure	Advanced electric machines and energy storage systems support technological innovation and sustainable industrial development.
CO4	state the concept on energy management strategies and case studies on EHV	SDG13	Climate Action	Energy management strategies in electric and hybrid vehicles contribute to reduced greenhouse gas emissions and environmental sustainability.

COMPOSITE MATERIALS

Class: B. Tech. VIII Semester		**Branch:** ME	
Course Code:	**U24ME802B**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : categorize composite materials with industrial applications

CO2 : classify manufacturing methods of polymer matrix composites

CO3 : distinguish metal matrix composites and select a suitable composite material based on the industrial applications

CO4 : analyse ceramic matrix composites, carbon/carbon composite material and their properties.

UNIT-I	**9 Hrs**

Introduction to Composites: Fundamentals, need, enhancement of properties, classification– Polymer Matrix Composites (PMC), Metal Matrix Composites (MMC), Ceramic Matrix Composites (CMC); reinforcement–particle reinforced composites, fibre reinforced composites; applications of various types of composites.

UNIT-II	**9 Hrs**

Polymer Matrix Composites: Polymer matrix resins-thermosetting resins, thermoplastic resins; reinforcement fibres – rovings, woven fabrics, non-woven random mats – different types of fibres; PMC manufacturing processes - hand layup processes, spray up processes, compression moulding, reinforced reaction injection moulding, resin transfer moulding, pultrusion, filament winding, injection moulding; Fibre Reinforced Plastics (FRP), Glass Fibre Reinforced Plastics (GRP).

UNIT-III	**9 Hrs**

Metal Matrix Composites: Characteristics, types, alloy vs. MMC, advantages, limitations, metal matrix reinforcements – particles, fibres; effect of reinforcement - volume fraction, rule of mixtures; processing– powder metallurgy process, diffusion bonding, stir casting, squeeze casting.

UNIT-IV	**9 Hrs**

Ceramic Matrix Composites: Engineering ceramic materials – properties, advantages, limitations; monolithic ceramics –need for CMC, ceramic matrix – types, oxide ceramics, non-oxide ceramics, aluminium oxide, silicon nitride; reinforcements – particles, fibres and whiskers.

Carbon /Carbon Composites: Advantages, limitations; Carbon fibre – chemical vapour deposition of carbon-on-carbon fibre preform, sol-gel technique; applications.

Textbook(s):

1. Chawla K.K., *Composite Materials*, 4th ed., Springer – Verlag, 2019.

Reference Book(S):

1. Agarwal.B.D. and Broutman, L. J., *Analysis and Performance of Fiber Composites*, 4th ed., John Wiley & Sons, 2017
2. Strong A.B., *Fundamentals of Composite Manufacturing*, 2nd ed., SME, 2007.
3. Sharma S.C., *Composite materials*, 1st ed., Narosa Publications, 2000.
4. Mathews F.L. and Rawlings R.D., *Composite materials: Engineering and Science*, Chapman and Hall, London, England, 1st ed., 1994.
5. Krishnan K., Chawla *Composite Materials Science and Engineering*, Springer (India) Private Limited, 2009

6. P.K. Mallick, *Fiber Reinforced Composite materials, Manufacturing and Design*, Newyork: CRC Press, Taylor and Francis Group, 2010.

Web and Video link(s):

1. http://nptel.ac.in/courses/101106038 ; NPTEL Video Lecture on Composite Materials by Prof. R. Velmurugan, Professor, Department of Aerospace Engineering, Indian Institute of Technology Madras.
2. http://nptel.ac.in/courses/101105662 ; NPTEL Video Lecture on *Mechanics of Composite Materials and Structures* by Prof. Mohammed Rabius Sunny, Professor, Department of Aerospace Engineering, Indian Institute of Technology Kharagpur.

Course Articulation Matrix (CAM):		U24ME802B: COMPOSITE MATERIALS												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME802B.1	2	2	2	1	-	1	1	-	1	-	1	2	1
CO2	U24ME802B 2	2	2	2	1	1	1	1	-	1	-	1	2	1
CO3	U24ME802B.3	2	2	2	2	1	1	1	-	1	-	1	2	1
CO4	U24ME802B.4	2	2	2	2	1	1	1	-	1	-	1	2	1
U24ME802B		2	2	2	1.5	1	1	1	-	1	-	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	*categorize composite materials with industrial applications*	SDG 9	Industry, Innovation and Infrastructure	Composite materials play a vital role in advanced engineering applications, industrial innovation, lightweight structures, and infrastructure development.
CO2	*classify manufacturing methods of polymer matrix composites*	SDG 12	Responsible Consumption and Production	Understanding composite manufacturing processes promotes efficient utilization of materials, reduction of waste, and sustainable manufacturing practices.
CO3	*distinguish metal matrix composites and select a suitable composite material based on the industrial applications*	SDG 9	Industry, Innovation and Infrastructure	The selection of advanced metal matrix composites improves product performance, industrial efficiency, and technological innovation in engineering applications.
CO4	*analyse ceramic matrix composites, carbon/carbon composite material and their properties.*	SDG 13	Climate Action	Advanced ceramic and carbon composites enable lightweight, high-temperature-resistant systems, improving energy efficiency and reducing environmental impact in aerospace and automotive applications.

COMPUTER INTEGRATED MANUFACTURING SYSTEMS			
Class: B. Tech. VIII – Semester		**Branch:** ME	
Course Code:	**U24ME802C**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : Compare and contrast types of automation and solve problems on production concepts using mathematical models

CO2 : develop NC part programming and explain robot configuration, group technology and cellular manufacturing

CO3 : build system models using basic building block

CO4 : develop ladder programs and suggest a suitable controller for a given industrial application

UNIT-I	9 Hrs

Automation in Production Operations: Introduction, functions in manufacturing, types of automations, automation strategies; production concepts and mathematical modelling; Organization and information processing in manufacturing system.

Numerical Control of Production Systems: Basic principle and elements of NC, CNC & DNC systems.

UNIT-II	9 Hrs

NC Part programming: Introduction, manual and computer aided part programming.

Introduction to Robots: Types, configuration, sensor technology and applications

Group Technology: Introduction, part families, classification and coding-OPITZ code; benefits of GT; Cellular manufacturing-Introduction, types of configurations.

CAPP: Introduction, types of process planning- retrieval and generative, applications**.**

UNIT-III	9 Hrs

Mechatronics: Introduction**,** systems, examples of mechatronic systems.

Basic Models: Mathematical models, mechanical system building blocks, electrical system building blocks, fluid system building blocks and thermal system building blocks.

System Models: Engineering system, rotational-translational system, electro- mechanical systems and hydraulic-mechanical system.

UNIT-IV	9 Hrs

Programmable logic controller: Basic PLC structure, Input/output processing, Ladder programming, Logic functions.

Closed Loop Controllers: Continuous and discrete processes; Control modes two step mode and proportional mode; derivative control, integral control, PID controller, digital controllers, velocity controllers and adaptive control.

Textbooks:

[1] Mikell P Groover, "*Automation, Production system and Computer Integrated Manufacturing*", 4th ed., Prentice Hall of India, New Delhi, 2016. (Chapters 1,2,8,9,10,11,16 and 24)

[2] Bolton W, "*Mechatronics*",*6th edn.*, Pearson Education, 2015 (Chapters 1, 8,9,11 and 21)

Reference Books:

[1] PN Rao, NK Tiwari and TK Kundra, *Computer Aided Manufacturing,* Tata McGraw-Hill, New Delhi,2012.

[2] Yorem Koran, *Computer Numerical Control of Manufacturing Systems,* McGraw-Hill, New Delhi, 2004.

[3] Nitaigour Premch and Mahalik, *Mechatronics: Principles concepts and applications,* Tata McGraw-Hill, New Delhi, 2012.
[4] HMT, *Mechatronics,* Tata McGraw-Hill, New Delhi, 2017.

Web and Video link(s):

https://nptel.ac.in/courses/112104289: NPTEL course on Computer Integrated Manufacturing by Prof. J. Ramkumar Prof. Amandeep Singh, IIT Kanpur

Course Articulation Matrix (CAM):		U24ME802C**: COMPUTER INTEGRATED MANUFACTURING SYSTEMS**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME802C.1**	2	2	-	-	-	1	-	-	1	-	1	1	2
CO2	**U24ME802C.2**	2	2	-	-	-	1	-	-	1	-	1	1	2
CO3	**U24ME802C.3**	2	2	2	2	2	1	-	-	1	-	1	1	2
CO4	**U24ME802C.4**	2	2	2	2	2	1	-	-	1	-	1	1	2
U24ME802C		2	2	2	2	2	1	-	-	1	-	1	1	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	Compare and contrast types of automation and solve problems on production concepts using mathematical models	SDG 9	Industry, Innovation and Infrastructure; Responsible	Optimizing production via mathematical models builds resilient infrastructure and fosters industrial efficiency.
CO2	*develop NC part programming and explain robot configuration, group technology and cellular manufacturing*	SDG 9	Industry, Innovation and Infrastructure; Responsible	These are core Industry 4.0 technologies that drive innovation and modernize industrial processes.
CO3	build system models using basic building block	SDG 12	Consumption and Production	Accurate system modeling ensures **efficient resource use**, reducing waste in the manufacturing lifecycle.
CO4	develop ladder programs and suggest a suitable controller for a given industrial application	SDG 8	Decent Work and Economic Growth	Automation through PLC/controllers promotes higher economic productivity and safer work environments.

GEOMETRICAL DIMENSIONING AND TOLERANCING

Class: B. Tech. – VIII-Semester		**Branch:** ME	
Course Code:	**U24ME802D**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : *explain the fundamentals of Geometric Dimensioning and Tolerancing (GD&T), limits, fits, datum systems, and material condition modifiers used in engineering drawings.*

CO2 : *apply form and orientation tolerances for interpreting and specifying geometric controls in engineering components.*

CO3 : *analyze location, profile, and runout tolerances and interpret GD&T symbols in engineering drawings for functional applications.*

CO4 : *evaluate inspection methods, coordinate measuring systems, and industrial applications of GD&T in CAD/CAM and manufacturing industries.*

UNIT-I	**9 Hrs**

Introduction to Geometric Dimensioning and Tolerancing (GD&T): Need and importance of GD&T, conventional tolerancing vs GD&T, ASME Y14.5 and ISO standards, limits, fits and tolerances, types of fits, feature control frame, datum features and datum systems, material condition modifiers – MMC, LMC and RFS.

UNIT-II	**9 Hrs**

Form and Orientation Tolerances: Straightness, flatness, circularity, cylindricity, parallelism, perpendicularity, angularity, tolerance zones, interpretation of geometric tolerances, applications of form and orientation tolerances in engineering components.

UNIT-III	**9 Hrs**

Location, Profile and Runout Tolerances: Position tolerance, concentricity, symmetry, profile of line, profile of surface, circular runout, total runout, composite tolerances, functional tolerancing, tolerance stack-up analysis, interpretation of GD&T symbols in engineering drawings.

UNIT-IV	**9 Hrs**

Inspection and Industrial Applications of GD&T: Gauges and inspection methods, coordinate measuring machine (CMM), surface roughness and surface finish symbols, GD&T applications in CAD/CAM and CNC machining, model-based definition (MBD), industrial applications in automotive and aerospace sectors, case studies and engineering drawing interpretation.

Textbook(s):

1. Alex Krulikowski, *Fundamentals of Geometric Dimensioning and Tolerancing*, 3rd ed., Delmar Cengage Learning, 2012.

Reference Book(S):

1. James D. Meadows, *Geometric Dimensioning and Tolerancing*, 1st ed., CRC Press, 2009.
2. Gene R. Cogorno, *Geometric Dimensioning and Tolerancing for Mechanical Design*, 2nd ed., McGraw-Hill Education, 2011.
3. David A. Madsen and David P. Madsen, *Engineering Drawing and Design*, 6th ed., Cengage Learning, 2016.
4. Fredric H. Wilson, *Geometric Dimensioning and Tolerancing Applications and Inspection*, 2nd ed., Cengage Learning, 2007.
5. ASME Y14.5-2018, *Dimensioning and Tolerancing Standard*, American Society of Mechanical Engineers, 2018.
6. ISO 1101:2017, *Geometrical Product Specifications (GPS) – Geometrical Tolerancing*, International Organization for Standardization, 2017.

Course Articulation Matrix (CAM):		U24ME802D: GEOMETRICAL DIMENSIONING AND TOLERANCING												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME802D.1	2	2	2	1	-	1	1		1	1	1	2	1
CO2	U24ME802D 2	2	2	2	1	1	1	1		1	1	1	2	1
CO3	U24ME802D.3	2	2	2	2	1	1	1		1	1	1	2	2
CO4	U24ME802D.4	2	2	2	2	1	1	1		1	1	1	2	2
U24ME802D		2	2	2	1.5	1	1	1		1	1	1	2	1.5
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	*explain the fundamentals of Geometric Dimensioning and Tolerancing (GD&T), limits, fits, datum systems, and material condition modifiers used in engineering drawings.*	SDG 4	Quality Education	Understanding GD&T fundamentals enhances technical knowledge and improves the skills required for quality engineering education, including interpreting engineering drawings.
CO2	*apply form and orientation tolerances for interpreting and specifying geometric controls in engineering components.*	SDG 9	Industry, Innovation and Infrastructure	Application of geometric tolerances improves precision engineering, manufacturing quality, and industrial product development.
CO3	*analyze location, profile, and runout tolerances and interpret GD&T symbols in engineering drawings for functional applications.*	SDG 12	Responsible Consumption and Production	Proper interpretation and application of GD&T reduce manufacturing errors, material wastage, and improve efficient production practices.
CO4	*evaluate inspection methods, coordinate measuring systems, and industrial applications of GD&T in CAD/CAM and manufacturing industries.*	SDG 9	Industry, Innovation and Infrastructure	Advanced inspection systems and GD&T applications support modern manufacturing industries, automation, and precision engineering infrastructure development.

ENERGY AUDIT AND MANAGEMENT			
Class: B. Tech. VIII–Semester		**Branch:** ME	
Course Code:	**U24ME803A**	**Credits:**	**3**
Hours/Week (L-T-P-E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

(based on cognitive skills acquired from the theory component)

CO1: analyze energy systems using energy audit techniques, utility costing, and financial evaluation methods for energy conservation applications

CO2 : assess the energy conservation opportunities in different thermal systems

CO3: evaluate the common energy conservation opportunities in different electrical utilities

CO4: examine the economic evaluation of energy conservation solutions

UNIT-I	9 Hrs

Energy Audit: Need of Energy Audit, Types of energy audit, Components of energy audit; Energy audit methodology, Instruments used in energy audit, Analysis and recommendations of energy audit, Energy audit reporting, Energy audit software, Current Energy Conservation Act

Energy Economics: Costing of Utilities-Determination of cost of steam, natural gas, compressed air and electricity; Financial Analysis Techniques (Numerical) - Simple payback, Time value of money, Net Present Value (NPV), Return on Investment (ROI), Internal Rate of Return (IRR), risk and sensitivity analysis

UNIT-II	9 Hrs

Energy Efficiency in Thermal Utilities: Energy performance assessment (Numerical) and efficiency improvement of Boilers, Furnaces, Heat exchangers, Cooling tower, Fans and blowers, Pumps, Compressed air system and HVAC systems; Assessment of steam distribution losses, Steam leakages, Steam trapping, Condensate and flash steam recovery system.

UNIT-III	9 Hrs

Energy efficiency in Electrical Utilities: Electricity billing, Electrical load management and maximum demand control, penalties, Power factor improvement and benefits; Selection and location of capacitors, Distribution and transformer losses; Electrical motors- types, efficiency and selection, Speed control, Energy efficient motors; Introduction of Electricity Act 2003,Lamp types and their features, recommended illumination levels, Lighting system performance assessment and efficiency improvement (Numericals).

UNIT-IV	9 Hrs

Cogeneration: Need, applications, advantages, classification, Introduction to Trigeneration.

Waste heat recovery- Classification, Application, Concept of Pinch analysis, Potential of WHR in Industries, Commercial WHR devices, saving potential. CDM projects and carbon credit calculations.

Case study: Energy Audit of Institute/Department.

Textbook:

1. Sonal Desai, *Handbook of Energy Audit,* McGraw Hill Education (India) Private Limited, 2015.

Reference Book(s):

1. Kennedy, William J., Turner, Wayne C., & Capehart, Barney L., *Guide to Energy Management,* The Fairmount Press, 8th ed., 2016.
2. Callaghan, P.W., *Design and Management for Energy Conservation*, Pergamon Press, Oxford, 1981.
3. Turner, W.C., *Energy Management Handbook*, Wiley, New York, 1982.

4. Y. P. Abbi, Shashank Jain., *Handbook on Energy Audit and Environment Management,* TERI Press, New Delhi, 2006.
5. Energy Manager Training Manual (www.energymanagertraining.com).
6. Guide book for National Certification Examination for Energy Managers and Energy Auditors, Bureau of Energy Efficiencies, 2015.

Web and Video link(s):

1. *https://onlinecourses.swayam2.ac.in/e-learning/preview/nou23_es05 NPTEL Video Lecture on Basic Principles of Energy Management & Energy Audit, by Dr. R. N. Patel & Mr. Akhilesh Kumar Tiwari, Professor of Electrical Engineering, Chhattisgarh Swami Vivekanand Technical University.*

Course Articulation Matrix (CAM):		U24ME803A: ENERGY AUDIT AND MANAGEMENT												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME803A.1	2	2	1	-	-	1	-	-	1	1	1	2	1
CO2	U24ME803A.2	2	2	1	-	-	1	-	-	1	1	1	2	1
CO3	U24ME803A.3	2	2	1	-	-	1	-	-	1	1	1	2	1
CO4	U24ME803A.4	2	2	1	-	-	1	-	-	1	1	1	2	1
U24ME803A		2	2	1	-	-	1	-	-	1	1	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	analyze energy systems using energy audit techniques, utility costing, and financial evaluation methods for energy conservation applications	SDG7	Affordable and Clean Energy	Energy auditing and conservation practices improve energy efficiency, reduce wastage, and promote sustainable and efficient use of energy resources.
CO2	assess the energy conservation opportunities in different thermal systems	SDG12	Responsible Consumption and Production	Energy conservation in thermal systems reduces resource wastage and promotes efficient industrial energy utilization.
CO3	evaluate the common energy conservation opportunities in different electrical utilities	SDG9	Industry, Innovation and Infrastructure	Improving energy efficiency in electrical utilities enhances sustainable industrial infrastructure and technological advancement.
CO4	examine the economic evaluation of energy conservation solutions adopted	SDG13	Climate Action	Economic evaluation of energy conservation solutions encourages adoption of sustainable practices that reduce environmental impact and carbon emissions.

PRODUCT DESIGN			
Class: B. Tech. V – Semester		**Branch:** ME	
Course Code:	**U24ME803B**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : apply design processes, planning and describe case studies

CO2 : compare the design concepts and evaluation techniques

CO3 : develop engineering specifications and industrial design

CO4 : evaluate the performance of the product for reliability and cost

UNIT-I	**9 Hrs**

Design Process: Describing mechanical design problems and processes–types of mechanical design problems, languages of mechanical design, constraints, goals and design decisions, designers and design teams.

Planning of design process: Overview of the design processes, organization techniques, developing design project plans, steps in planning, case studies

UNIT-II	**9 Hrs**

Design concept generation and evaluation: Technique for functional decomposition, generating and developing concepts, evaluation based on feasibility judgment, technology – readiness assessment, go/no go screening, decision matrix

UNIT-III	**9 Hrs**

Development of engineering specifications: Steps in development of engineering specification, identification of customer\s requirements, Quality Functional Deployment (QFD) Industrial Design: Design for emotion and experience, human behavior in design

UNIT-IV	**9 Hrs**

Product Evaluation: Importance and goals of performance evaluation, robust design, sensitivity analysis, Cost estimation in design, design for reliability, design for environment and maintenance

Textbook(s):

1. David G. Ullman, *The Mechanical Design Process*,4th ed. McGraw Hill, New York,2011.

Reference Book(S):

1. George E. Dieter, *Engineering Design*, 4th ed. McGraw Hill Education, New Delhi, 2013.
2. Karl T. Ulrich and Steven D. Eppinger, *Product Design and Development* 2nd ed. McGraw Hill Education, New Delhi, 2012.
3. E.N.Baldwin and B.W. Niebel, *Designing for Production,* 2nd ed. Homewood, Illinois, 1975.
4. J.C.Jones, *Design Methods, Seeds of Human Futures,* 3rd ed. John Wiley, New York, 1978.
5. J.G.Bralla, *Handbook of Product Design for Manufacture,* 2nd ed. McGraw-Hill, New York, 1988.

Web and Video link(s):

https://youtu.be/FIVA6dBRv4I?si=2nu2nCH3M04uWC1q *NPTEL Video Lecture on Product Design and Development by Dr. Inderdeep Singh, Professor of Mechanical and Industrial Engineering, IIT Roorkee*

Course Articulation Matrix (CAM):		U24ME803B : PRODUCT DESIGN												
CO		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	U24ME803B.1	1	1	2	1	-	1	-	1	1	2	1	2	2
CO2	U24ME803B.2	1	1	2	1	-	1	-	1	1	2	1	2	2
CO3	U24ME803B.3	1	1	2	1	-	1	-	1	1	2	1	2	2
CO4	U24ME803B.4	1	1	2	1	-	1	-	1	1	2	1	2	2
U24ME803B		1	1	2	1	-	1	-	1	1	2	1	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	CO Statement *The student should be able to…*	Relevant SDG	SDG Description	Mapping Justification
CO1	apply design processes, planning and describe case studies	SDG9	Industry, Innovation and Infrastructure	Promotes innovative and sustainable product development
CO2	compare the design concepts and evaluation techniques	SDG12	Responsible Consumption and Production	Supports efficient use of materials and sustainable production
CO3	develop engineering specifications and industrial design	SDG9	Industry, Innovation and Infrastructure	Promotes innovative engineering and industrial product development
CO4	evaluate the performance of the product for reliability and cost	SDG12	Responsible Consumption and Production	Promotes efficient resource utilization and reduced waste

SUSTAINABILITY IN MANUFACTURING			
Class: B. Tech. VIII – Semester		**Branch:** ME	
Course Code:	**U24ME803C**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : interpret the concept of sustainable manufacturing, waste, pollution management, and environment-friendly materials.

CO2 : apply sustainable manufacturing tools, techniques of sustainable manufacturing to life cycle analysis and impact assessment.

CO3 : analyse eco-friendly product design methods, sustainability assessment frameworks and corporate social responsibility in sustainable product development.

CO4 : examine green manufacturing techniques, lean manufacturing practices, and green supply chain strategies for improving environmental and operational efficiency in industries.

UNIT-I	9 Hrs

Introduction: Concepts of sustainability and sustainable development, sustainable development goals, need for sustainable development, components of sustainability social, economic, environmental dimensions, linkages between technology and sustainability, sustainable manufacturing –scope, need and benefits.

Waste Management: Types, sources and nature of wastes, waste processing, green processing & engineering operations, energy recovery, and 3R & 6R principles, waste assessment and strategies for waste reduction in green manufacturing

Environment Friendly Materials: Materials for sustainability, eco-friendly and new age energy efficient and smart materials, and selection; control on use of renewable materials, bio-degradable materials recycling of materials.

UNIT-II	9 Hrs

Sustainable Manufacturing Tools: System model architecture and module, Design and planning, tools for green manufacturing (Qualitative Analysis), Consumption analysis, Life Cycle Analysis, Efficiency, Sustainability Standards for green manufacturing (ISO 14000 and OHSAS 18000), Waste stream mapping and application, Product Life Cycle of manufactured goods**.**

Environmental Impact Assessment Methods: CML, EI 95 and 99, ISO 14001 EMS and PAS 2050 standards, Environmental Impact parameters, Interactions between energy and technology, and their implications for environment and sustainable development**.**

UNIT-III	9 Hrs

Design for Recycling: Eco friendly product design methods, Methods to infuse sustainability in early product design phases.

Frameworks for Measuring sustainability: Indicators of sustainability, Environmental, Economic, Societal and Business indicators, Concept Models and Various Approaches, Product Sustainability and Risk/Benefit assessment, Corporate Social Responsibility**.**

UNIT-IV	9 Hrs

Green manufacturing techniques: Dry and near-dry machining, edible oil-based cutting fluids, cryogenic machining for eco-efficiency, Lean manufacturing and techniques.

Case Studies: Carbon footprints in transportation, implementation of lean manufacturing at industries, green packaging and supply chain, product life cycle management.

Textbook(s):

1. G. Atkinson, S. Dietz, E. Neumayer, *Handbook of Sustainable Development*, Edward Elgar Publishing Limited,2008, United Kingdom.
2. Dornfeld, D.A. ed., 2012. *Green manufacturing: fundamentals and applications*, Springer Science & Business Media,2013, New York.

Reference Book(S):

1. D. Rodick, Industrial Development for the 21st Century: Sustainable Development Perspectives, 2007, UN New York.
2. Rogers, P.P., Jalal, K.F. and Boyd, J.A., *An Introduction to Sustainable Development*, Earthscan, 2007, London.
3. Ashby, M. F. *Materials and the environment: eco-informed material choice*. Elsevier, 2012.
4. Philip Lawn, *Sustainable Development Indicators in Ecological Economics*, Edward Elgar Publishing Limited, 2006, UK.
5. Chandan Deep Singh, *Developments in Sustainable Manufacturing Management Key Concepts and Tools*, Emerald Publishing Limited, 1st edition 2025, England.
6. https://sdgs.un.org/goals

Web and Video link(s):

https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_mg85 ; *NPTEL Video Lecture on Sustainability Through Green Manufacturing Systems: An Applied Approach by PROF. DEEPU PHILIP Biaswas, Professor of Industrial & Management Engg, AND PROF. AMANDEEP SINGH Department of Mechanical Engineering IIT Kharagpur.*

Course Articulation Matrix (CAM):		**U24ME803C: SUSTAINABILITY IN MANUFACTURING**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24 ME803C.1**	2	2	1	-	-	1	1	-	1	-	1	2	1
CO2	**U24 ME803C.2**	2	2	1	-	-	1	1	-	1	-	1	2	1
CO3	**U24 ME803C .3**	2	2	1	-	-	1	1	-	1	-	1	2	1
CO4	**U24 ME803C.4**	2	2	1	-	-	1	1	-	1	-	1	2	1
U24ME803C		2	2	1	-	-	1	1	-	1	-	1	2	1
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	interpret the concept of sustainable manufacturing, waste, pollution management, and environment-friendly materials	**SDG 12**	Responsible Consumption and Production	focuses on sustainable manufacturing practices, waste minimization, recycling, pollution control, and eco-friendly materials which directly support sustainable production and responsible resource utilization.
		SDG 13	Climate Action	The study of pollution management, energy recovery, and green processing contributes to reducing environmental impacts and mitigating climate change.
CO2	apply sustainable manufacturing tools, techniques of sustainable manufacturing to life cycle analysis and impact assessment	SDG 9	Industry, Innovation and Infrastructure	promotes the use of innovative sustainable manufacturing tools, standards, and assessment methods for developing efficient and resilient industrial systems.
		SDG 12	Responsible Consumption and Production	Life cycle analysis, environmental management standards, and sustainability tools help industries optimize resources and reduce waste generation.
CO3	analyze eco-friendly product design methods, sustainability assessment frameworks and corporate social responsibility in sustainable product	**SDG 9**	Industry, Innovation and Infrastructure	Eco-friendly product design and sustainability frameworks encourage innovation in product development and industrial practices.
		SDG 8	Decent Work and	Corporate Social Responsibility (CSR) and sustainability assessment contribute to

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
	development.		Economic Growth	ethical industrial growth and responsible business practices.
		SDG 12	Responsible Consumption and Production	Sustainable product design and recycling approaches support efficient use of materials and sustainable production systems
CO4	examine green manufacturing techniques, lean manufacturing practices, and green supply chain strategies for improving environmental and operational efficiency in industries.	**SDG 12**	Responsible Consumption and Production	Green manufacturing, lean techniques, waste reduction, and sustainable supply chain management directly support sustainable industrial production practices.
		SDG 13	Climate Action	Carbon footprint reduction and eco-efficient manufacturing techniques contribute to lowering greenhouse gas emissions and environmental impacts..
		SDG 9	Industry, Innovation and Infrastructure	Adoption of advanced green manufacturing and supply chain practices enhances sustainable industrial infrastructure and innovation.

INDUSTRIAL MANAGEMENT			
Class: B. Tech. VIII – Semester		**Branch:** ME	
Course Code:	**U24ME803D**	**Credits:**	**3**
Hours/Week (L-T-P- E):	**2-1-0-3**	**CIE:**	**60%**
Total Number of Teaching Hours:	**36 Hrs**	**ESE:**	**40%**

Course Learning Outcomes (COs)

After completion of this course, the students should be able to,

CO1 : apply the concepts of management in their chosen field of profession and evaluate different types of organizational structures.

CO2 : design the plant layout for production types; make use of work study methods to improve the productivity of the processes and systems.

CO3 : evaluate strategies that align resources, operations and employees toward shared long-term goals; develop integrated marketing mix strategies to deliver superior value to target customers and build long-term brand equity.

CO4 : apply the principles of human resource management, supply chain management and value engineering to enhance workforce productivity, organizational efficiency and operational performance respectively.

UNIT-I	9 Hrs

Introduction To Management: Concepts of management - nature, importance and functions of management, Taylor's scientific management theory, Fayol's principles of management, Maslow's theory of human needs, Douglas McGregor's theory X and theory Y, Leadership styles, Social responsibilities of management.

Organizational Structures: Types and structures of organization (Line organization, line and staff organization, functional organization, committee organization, matrix organization, team structure), their merits, demerits and suitability.

UNIT-II	9 Hrs

Plant location and plant layout: Factors governing plant location, comparison of rural and urban sites-methods for selection of plant; types of plant layouts, their advantages and disadvantages, applications.

Work study: Importance, application; Method study -Work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, flow process charts, string diagrams and Therbligs; Time study - Elements of time study, time study procedure, standard time calculation, principles of Ergonomics.

UNIT-III	9 Hrs

Strategic Management: Vision, mission, goals, objectives, policy, strategy, programmes, elements of corporate planning process, value chain analysis, SWOC analysis with a case study, steps in strategy formulation and implementation.

Marketing management: Functions of marketing, marketing mix (4Ps - Product, Price, Place, and Promotion), marketing strategies based on product life cycle, channels of distribution.

UNIT-IV	9 Hrs

Human Resources Management (HRM): Concepts of HRM; personnel management and industrial relations, basic functions of HR manager; Job evaluation - its importance and types, merit rating, quantitative methods, wage incentive plans and types.

Supply Chain Management: objectives, orientation and implementation of supply chain principles, purchasing function, single source vs multi source supply relationship.

Value analysis: Value engineering, definition, types of values, objectives, phase of value analysis, Fast diagram, implementation procedure

Textbook(s):

1. **O.P. Khanna,** Industrial Engineering and Management, New Delhi: Dhanpat Rai Publications, 2018.

Reference Book(S):

1. Martand T. Telsang, Industrial Engineering and Production Management, New Delhi: S. Chand Publishing, 2018.
2. S.C. Sharma and T.R. Banga, Industrial Engineering and Management, New Delhi: Khanna Publishers, 2017.
3. S.N. Chary, Production and Operations Management, New Delhi: McGraw-Hill, 2019.
4. William J. Stevenson, Operations and Supply Chain Management, New York: McGraw-Hill, 2021.

Web and Video link(s):

https://nptel.ac.in/courses/110107141; *NPTEL Video Lecture on Production and Operation Management by Prof. Rajat Agrawal, Professor of Management Studies, IIT Roorkhee.*

Course Articulation Matrix (CAM):		U24ME803D**: INDUSTRIAL MANAGEMENT**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	**U24ME803D.1**	2	1	-	-	-	1	1	-	1	-	1	2	-
CO2	**U24ME803D.2**	2	2	2	-	-	1	1	-	1	-	1	2	2
CO3	**U24ME803D.3**	2	1	-	-	-	1	1	-	1	-	1	2	-
CO4	**U24ME803D.4**	2	2	-	-	-	1	1	-	1	-	1	2	-
U24ME803D		2	1.5	2	-	-	1	1	-	1	-	1	2	**2**
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement** *The student should be able to…*	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	apply the concepts of management in their chosen field of profession and evaluate different types of organizational structures.	SDG 8	Decent Work and Economic Growth	Applying professional management principles fosters efficient organizational structures, which are vital for sustainable economic growth and productive employment.
CO2	design the plant layout for production types; make use of work study methods to improve the productivity of the processes and systems	SDG 9 SDG 12	Industry, Innovation and Infrastructure; Responsible Consumption and Production	Direct focus on optimizing industrial plant layouts and systems to enhance productivity and build resilient industrial infrastructure. Work-study methods reduce waste and improve resource efficiency within the production process.
CO3	evaluate strategies that align resources, operations and employees toward shared long-term goals; develop integrated marketing mix strategies to deliver superior value to target customers and build long-term brand equity.	SDG 8 SDG 12	Decent Work and Economic Growth Consumption and Production	Aligning employees and resources toward long-term goals supports stable job environments and sustainable business practices. Building "long-term brand equity" involves sustainable value creation for customers, encouraging responsible marketing.
CO4	apply the principles of human resource management, supply chain management and value engineering to enhance workforce productivity, organizational efficiency and operational performance respectively.	SDG 8 SDG 12	Decent Work and Economic Growth Consumption and Production	HRM principles directly improve workforce productivity and promote decent work conditions. Value engineering and SCM optimize supply chains to minimize waste and maximize resource efficiency

MAJOR PROJECT PHASE II			
Class: B. Tech. VIII – Semester		**Branch:** ME	
Course Code:	U24ME804	**Credits:**	**6**
Hours/Week (L-T-P- E):	**0-0-12-12**	**CIE:**	**60%**
Total Number of Teaching Hours:	**-**	**ESE:**	**40%**

Course Learning Outcomes (COs):

After completion of this course, the students should be able to,

Upon completion of the major project work, students will be able to…

CO1: review research literature, formulate problem, apply knowledge of mathematics, sciences, engineering fundamentals, experimental and data analysis techniques; synthesize technical knowledge and innovative approaches to generate suitable solutions for real-world complex engineering problems (Technical skills)

CO2: design a system or product based on product/customer specifications; develop, analyze, and critically evaluate the design alternatives in order to justify the solutions to a real-world problem guided by ethical, environmental, societal and sustainable development considerations; use modern engineering and IT tools to design, build and test a prototype within specified project timeline and budget (Problem solving and critical thinking skills)

CO3: apply project management and organizational skills; demonstrate integrity, leadership, creativity, professional and ethical responsibilities as an individual and as a member or leader to produce time-sensitive deliverables in a multi-disciplinary team (Ethics and teamwork)

CO4: collate the results, compare performance of prototype to design specifications and present clearly and effectively the proposed solution, conclusions and/or recommendations in written (report, poster, technical paper), oral (presentations) and multimedia formats (video pitch) and engage in self-directed independent learning and life-long learning demonstrating the KSQ of a professional engineer (Communication skills and life-long learning)

1. **Major project work shall be continued in 8th semester as major project *phase-II*:** All the major project teams shall take the *phase -I* work forward and complete the remaining work as *Phase-II* in the 8th semester.
2. Final Year Major Project work represents the culmination of study towards the B. Tech degree. **Major project offers an opportunity to integrate the knowledge acquired from various courses and apply it to solve real-world complex engineering problems**. The **student learning assessment process** (SLAP) shall include good number of presentations, demonstration of work undertaken, submission of a project report, writing project paper in scientific journal style & format, preparing project poster and creating video pitch on the complete project
3. Activities of major project SLAP shall be planned in such a way to ensure that the students acquire the essential knowledge, skills and qualities (KSQ) of a professional engineer.
4. **Team work:** Major project work is a team work
   (i) The students of a project team shall work together to achieve a common objective.
   (ii) Every student of a project team is expected to function effectively as an individual, and also with others as a team member in an ecosystem of team having knowledge diversity, gender diversity, social and cultural diversity among its members.
5. Every student is expected to put approximately **168 hours of work** into the major project phase-II course over the 12 weeks of 8th semester.
6. **Major project work *Phase-II*: 8th semester**
   (i) The convener DPEC shall release complete schedule of *phase-II* CIE during last week of 7th semester (*well in advance before start of 8th semester*), immediately after completion of Progress Presentation-I, so that student teams would complete the scheduled works during inter-semester break and get ready with informative, confident and comfortable presentation for progress presentation-II.
   (ii) The project supervisors: The project supervisors are expected to guide the students to systematically continue the phase-I work, useful work during inter- semester break,

meeting the deadlines as proposed in project timeline.

(iii) The project supervisors shall ensure students focus on the project objectives and expected deliverables

(iv) The project supervisors shall ensure students have sufficient resources for successful project completion.

(v) The project supervisors shall ensure students have sufficient resources for successful project completion.

(vi) The project supervisors shall continue guiding students on

(a) *Knowledge, skills and qualities (KSQ) of a professional engineer to be acquired* to propose solutions and design the systems to theidentified real-world problems.

(b) *Problem analysis* - to identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences

(c) *Applying engineering knowledge* - to apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems

(d) *Design/development of solutions* - to design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental Considerations

(e) *Conduct investigations of complex problems* - to use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions

(f) *Modern tool usage* – to create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations

(g) *The Engineering and the world* – to apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice

(h) *Ethics* – to apply ethical principles and commit to professional ethics, responsibilities, and norms of the engineering practice

(i) *Individual and team work* – to function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings

(j) *Communication* – to communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions

(k) *Project management and finance* – to demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments

(l) *Life-long learning* – to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

(vii) The project supervisors are also expected to continuously emphasize and guide the students on

(a) **Following project timeline**: completing the tasks as planned in project timeline

(b) **Meeting Cadence:**

i. **Regular meetings with supervisor:** Short and frequent meetings increase a team's work momentum. Regular meetings with supervisor to review the status of project are very essential. All students of the team shall participate in discussions and take notes.

ii. **Meeting Frequency: Semi-weekly cadence,** i.e., the meeting frequency shall be **twice a week.** Due weightage will be given to meeting cadence and

considered for evaluation during presentations, i.e., number of planned meetings and number attended by students

(c) **Project Log Book:** The activity journaling in project log book is very important for a successful project.

i. Project log book is a written record showing the daily project activity on project goals from the very first thing like starting the project (an introduction statement what the project is all about), to the completion of the work (including the final results, and whether project met the core objectives / outcomes, etc.).

ii. In project log book, the activities like regular meetings with project supervisor, and work carried out on daily/weekly basis are to be recorded. This ensures that the student progress is being monitored well.

iii. The project supervisor shall regularly check the log book of every student of project team and endorse each and every activity by affixing his signature with date. With this, the number of planned meetings and number attended by the students will be also monitored.

iv. Log books are to be shown during all presentations and will be graded along with the project.

v. At the conclusion of the project work *phase-II*, the supervisor shall specifically comment, in the project log book, on whether the project team met each of the project work outcomes and to give evidence which describes the quality of work. For project teams, this also serves as self-assessment.

(d) **Writing down whatever is done and making notes of whatever is read**. Writing down the procedures / models followed, designs made, experiments conducted, simulations carried out, intermediate results obtained, ***difficulties faced and how they were fixed*** are very important. This kind of documenting the whole process as we go with project implementation is a very effective way and will help preparing a well- documented report having original content. Note down and include information about all the resources that you used, magazines, Journals, patents, books, and so on. This information will be needed for the bibliography in your project report. On the other hand, documenting a report ***on the spur of the moment*** would end up copying things from other sources resulting in a plagiarized document.

(e) The relevant knowledge, skills and qualities (**KSQ**) an engineering graduate should possess, which can be specially acquired by participating in major project work

(f) **Good and sufficient literature review**: Literature review is a description and analysis of information related to the topic of project work. Reading good number of review articles, research articles published in recent issues of peer reviewed journals, technical magazines, patents, reference books on the topics of potential interest, will help one understand what has already been discovered and what questions remain to identify gaps in the literature.

(g) Completing the proposed work by the end of *phase-II*

(h) Right conduct of research to promote academic integrity, honesty and time management

(i) Preparing a well-documented overall project report in proper format, covering the complete work carried out during both the phases (*phase-I and phase-II*).

(j) Consequences of plagiarism, and use of anti-plagiarism software to detect plagiarism in the report

(k) Submission of major project work report within acceptable plagiarism levels (including AI Plagiarism), as per the ***Anti-plagiarism policy-2020 of our institute***

(l) **Video pitch on complete project work**: Capturing short videos, photos, screenshots on experiments conducted, simulations carried out, prototype / working model / process / software package / system developed during course

of project execution, photos showing interaction with supervisor for creating a short video pitch on the complete work done during both phases (*phase-I and phase-II*).

(m) **Project Paper**: Writing a technical paper at the end of *phase-II* based on the solution(s) proposed, results obtained and prototype / working model / process / software package / system developed, for submission to a reputed non-predatory conference/non-paid peer reviewed journal.

(n) **Project poster**: At the end of phase-II, the project teams shall have to present their project in the form of posters, at the time of demonstration of complete porotype / working model / software package / system developed.

(viii) **Phase – II evaluation**: There shall be only Continuous Internal Evaluation (CIE) for major project work *phase-I* with following components

(a) **Progress Presentation -II** *(during third / fourth week of 8th semester):* The progress presentation-II shall include the identified problem, objective(s), literature review, expected outcome(s), results of work done as per project plan timeline.

i. **Following project timeline**: The project timeline shall be meticulously followed and the tasks shall be completed as planned in project timeline.

ii. 80-85% of work is expected to be completed

iii. Project teams shall compulsorily show the following as part of their progress presentation-II

1. *The slides on project timeline and*
2. *A table showing targeted tasks as per timeline and status – whether tasks accomplished?*

iv. **Project log book**: Every student of the Project team shall compulsorily show the activity journaling in the log book (with due signatures of project supervisor) during presentations

(b) **Final Presentation** *(during penultimate week of 8th semester):* **Project supervisor shall ensure that the project team has accomplished 100% of work proposed**. The project team shall

i. **Follow project timeline**: The project timeline shall be meticulously followed and the tasks shall be completed as planned in project timeline.

ii. compulsorily show the following as part of their final presentation

1. *The slides on project timeline and*
2. *A table showing targeted tasks as per timeline and whether all the identified tasks accomplished?*

iii. **show project log book**: Every student of the Project team shall compulsorily show the complete activity journaling in the log book (*with due signatures of project supervisor*)

iv. present complete results & analysis

v. **demonstrate the completed project**: working model / process / software package / system developed

vi. demonstrate the completed project with the **project poster presentation**

(ix) **Evaluation for Major project phase-II:** There shall be continuous internal evaluation (CIE) and end semester examination (ESE). The evaluation for *phase-II* shall be as given below:

Assessment	Weightage
A. CIE **(i) Supervisor Assessment(10%)** **(ii) DPEC Assessment (50%)** *(a) Progress presentation-II (10%)* *(b) Final presentation(10%)* *(c) Working model/process/software package/system developed(20%)* *(d) Project video pitch (5%)* *(e) Projectpaper(5%)*	**60%**

B. ESE *(i) Well-documented proj ectreport(15%)* *(DPEC shall evaluate the project reports, as per the rubrics, well before the ESE. At thetimeofESE,evaluatedprojectreportmarksshallbepostedintheawardlist,alongwiththe ESE oral presentation marks. Students shall appear for Viva-Voce with project report)* *(ii) Oral presentation with PPTs and viva-voce(10%)* *(iii) Project poster(5%)* *(DPEC shall evaluate the project poster, as per the rubrics, well before the ESE. At the time of ESE, evaluated project poster marks shall be posted in the award list. Students shall appear forgiven-Voce with project tposter)* *(iv) SDG (5%)* *(v) Research Orientation (5%)*	**40%**
Total Weightage	**100%**

(a) **Working Model:** Every project team shall be required to develop a working model/ process/software package/system on the chosen work. The completed working model/ process/software package/system shall be demonstrated during the final presentation at the end of *phase-II*.

(b) **Video pitch**: Every project team shall be required to create a pitch video, which is a video presentation on their major project work *phase-I & phase-II*. The project team shall present the produced video pitch during Final presentation. The produced video pitch should

(i) be 3 to 5-minute-long video (no longer than 5 minutes)

(ii) be concise and to the point, on the problem, proposed solution and its salient features.

(iii) show project timeline and sample page of log book

(iv) highlight the various stages during project implementation with the help of short videos / photos / screenshots on experiments conducted, simulations carried out, prototype / working model / process / software package / system developed as part of proposed solution and also photos showing team interactions with supervisor and the team working in the lab on project.

(v) discuss the impact of proposed solution in *ethical, environmental, societal and sustainable development contexts.*

(vi) emphasize key points about *business idea, potential market for the proposed solution*

(c) **Project poster**: At the end, the project teams shall present their project in the form of posters (A2 size). The teams shall have to present their work during the poster presentation session scheduled at the end of the 8^{th} semester, at the time of demonstration of complete porotype / working model / software package / system developed.

(d) **Well-documented plagiarism-cleared project report**: Every project team shall be required to submit a well-documented project report on the work carried out, as per the format specified by the DPEC. The report should clear plagiarism check as per the anti-plagiarism policy-2020 of the institute. The following shall compulsorily be included in the Results-Chapter of the project report

(i) Photos / screen shots taken at various stages during the development of working model/ process/software package/system as part of Results-Chapter

(ii) Snapshot of final working model/ process/software package/system developed

(iii) Pictures of the team working in the lab, the team discussing with the project supervisor, working on creative project, or an event they are attending for work.

(iv) All *these photos / screen shots shall be properly referred in the project report by assigning figure numbers*

(e) **Tangible outcomes of project work in Conclusions - Chapter:** These are the lessons learnt from doing a project work. The students have to describe in their own words what they learnt from the project work experience. They have to describe what specific KSQs are acquired by them, with reference to the expected COs, after successful completion of major project work. Finally, a table depicting systematic mapping of what they have learnt and the expected major project work COs, is to be shown in the conclusions chapter.

(f) **Student feedback on major project in Conclusions - Chapter:** To gather information on whether project work was useful and gave practical experience on chosen field of interest, and other learning, a well-defined feedback questionnaire (*made available by the dept*) with closed and open questions shall be kept in the conclusions chapter of the project report.

(x) It is mandatory for

(a) every student of the team to appear for ESE oral presentation and viva-voce, to qualify for course evaluation

(b) every project team to write a technical paper based on the solution(s) proposed, results obtained and prototype/working model/process/software package/system developed, for submission to a reputed non-predatory conference/non-paid peer-reviewed journal

(c) every project team shall be required to create a pitch video, which is a video presentation on their major project work phase-I & phase-II

(d) every project team shall present their project in the form of a poster, during the demonstration of complete prototype/working model/software package/system developed

(xi) The student has to register for the Major project work phase-II as supplementary examination in the following cases:

(a) he/she is absent for oral presentation and viva-voce as part of ESE presentation

(b) he/she fails to fulfill the requirements of Major project work phase-II evaluation as per specified guidelines

(xii) Supplementary examination for Major project work phase-II

(a) The CoE shall send the list of students registered for supplementary examination to the HoDs concerned

(b) The DPEC, duly constituted by the HoD, shall conduct Major Project Phase-II supplementary exam and send the award list to the CoE within the stipulated time

Course Articulation Matrix (CAM):		**U24ME804: MAJOR PROJECT PHASE II**												
CO		**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**
CO1	U24ME804.1	3	3	2	3	2	1	1	1	1	1	2	2	2
CO2	U24ME804.2	3	2	3	2	2	1	2	1	1	2	2	2	2
CO3	U24ME804.3	1	1	1	1	1	2	1	1	2	2	1	-	-
CO4	U24ME804.4	1	1	1	2	2	1	2	1	2	1	2	-	-
U24ME804		2	1.75	1.75	2	1.75	1.25	1.5	1	1.5	1.5	1.75	2	2
3 – HIGH, 2 – MEDIUM, 1 - LOW														

CO–SDG Alignment Matrix				
CO	**CO Statement (The student should be able to…)**	**Relevant SDG**	**SDG Description**	**Mapping Justification**
CO1	review research literature, identify gaps in the literature, formulate problem, apply knowledge of mathematics, sciences, engineering fundamentals, experimental and data analysis techniques; synthesize technical knowledge and innovative approaches to generate suitable solutions for real- world complex engineering problems (Technical skills)	**SDG 13**	Industry, Innovation and Infrastructure	Research-based innovation and development of advanced ECE solutions contribute to technological progress, industrial growth, and infrastructure development.
CO2	design a system or product based on product/customer specifications; develop, analyze, and critically evaluate the design alternatives in order to justify the solutions to a real-world problem guided by ethical, environmental, societal and sustainable development considerations; use modern engineering and IT tools to design, build and test a prototype within specified project timeline and budget (Problem solving and critical thinking skills)	**SDG 12**	Responsible Consumption and Production	Sustainable design practices, efficient resource utilization, and environmentally responsible engineering solutions promote responsible production and innovation.
CO3	Apply project management and organizational skills; demonstrate integrity, leadership, creativity, professional and ethical responsibilities as an individual and as a member or leader of a multidisciplinary team.	**SDG 11**	Sustainable Cities and Communities	Collaborative development of engineering solutions addressing societal needs contributes to sustainable and resilient communities.
CO4	Collate the results, compare performance of prototype to design specifications and present clearly and effectively the proposed solution, conclusions and/or recommendations in written (report, poster, technical paper), oral (presentations) and multimedia formats (video pitch) and engage in self-directed independent learning and life-long learning demonstrating the KSQ of a professional engineer (Communication skills and life-long learning)	**SDG 4**	Quality Education	Technical communication, knowledge dissemination, and self-directed learning support continuous education and professional growth.