



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

AK23 Regulations

Course structure for Four Year Regular B.Tech. Degree Program

(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

INDUCTION PROGRAMME

S. No	Course Name	Category	L-T-P-C
1	Physical Activities--Sports, Yoga and Meditation, Plantation	MC	0-0-6-0
2	Career Counselling	MC	2-0-2-0
3	Orientation to all branches –career options, tools, etc.	MC	3-0-0-0
4	Orientation on admitted Branch—corresponding labs, tools and platforms	EC	2-0-3-0
5	Proficiency Modules & Productivity Tools	ES	2-1-2-0
6	Assessment on basic aptitude and mathematical skills	MC	2-0-3-0
7	Remedial Training in Foundation Courses	MC	2-1-2-0
8	Human Values & Professional Ethics	MC	3-0-0-0
9	Communication Skills –focus on Listening, Speaking, Reading, Writing skills	BS	2-1-2-0
10	Concepts of Programming	ES	2-0-2-0



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Course structure for Four Year Regular B.Tech. Degree Program
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MECHANICAL ENGINEERING (ME)
B. Tech – I Year I Semester

AK23 Regulations

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	BS	23ABS9903	Engineering Physics	2	1	0	3	30	70	100
2	BS	23ABS9904	Linear Algebra & Calculus	2	1	0	3	30	70	100
3	ES	23AES0201	Basic Electrical & Electronics Engineering	2	1	0	3	30	70	100
4	ES	23AES0301	Engineering Graphics	1	0	4	3	30	70	100
5	ES	23AES0501	Introduction to Programming	2	1	0	3	30	70	100
6	ES	23AES0503	IT Workshop	0	0	2	1	30	70	100
7	BS	23ABS9908	Engineering Physics Lab	0	0	2	1	30	70	100
8	ES	23AES0202	Electrical & Electronics Engineering Workshop	0	0	3	1.5	30	70	100
9	ES	23AES0502	Computer Programming Lab	0	0	3	1.5	30	70	100
10	HM	23AHM9904	NSS/NCC/Scouts & Guides/Community Service	-	-	1	0.5	50	-	50
Total				9	4	15	20.5	320	630	950

B. Tech – I Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	HM	23AHM9901	Communicative English	2	0	0	2	30	70	100
2	BS	23ABS9902	Engineering Chemistry	2	1	0	3	30	70	100
3	BS	23ABS9905	Differential Equations & Vector Calculus	2	1	0	3	30	70	100
4	ES	23AES0101	Basic Civil & Mechanical Engineering	2	1	0	3	30	70	100
5	PC	23APC0101	Engineering Mechanics	2	1	0	3	30	70	100
6	HM	23AHM9902	Communicative English Lab	0	0	2	1	30	70	100
7	BS	23ABS9907	Engineering Chemistry Lab	0	0	2	1	30	70	100
8	ES	23AES0302	Engineering Workshop	0	0	3	1.5	30	70	100
9	PC	23APC0301	Engineering Mechanics Lab	0	0	3	1.5	30	70	100
10	HM	23AHM9903	Health and wellness, Yoga and Sports	-	-	1	0.5	50	-	50
Total				10	4	11	19.5	320	630	950



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MECHANICAL ENGINEERING (ME)
B. Tech – II Year I Semester

AK23 Regulations

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	BS	23ABS9911	Numerical Methods & Transform Techniques	2	1	0	3	30	70	100
2	HM	23AHM9905	Universal Human Values	2	1	0	3	30	70	100
3	ES	23AES0303	Thermodynamics	2	0	0	2	30	70	100
4	PC	23APC0302	Mechanics of Solids	2	1	0	3	30	70	100
5	PC	23APC0303	Material Science and Metallurgy	2	1	0	3	30	70	100
6	PC	23APC0304	Mechanics of Solids and Materials Science Lab	0	0	2	1	30	70	100
7	PC	23APC0305	Computer-Aided Machine Drawing	0	0	3	1.5	30	70	100
8	ES	23AES0402	Embedded Systems and IoT	0	0	3	1.5	30	70	100
9	SC	23ASC0501	Python programming	0	1	2	2	30	70	100
Total				10	5	10	20	270	630	900

B. Tech – II Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	HM	23AHM0301	Industrial Management	2	0	0	2	30	70	100
2	BS	23ABS9914	Complex Variables, Probability and Statistics	2	1	0	3	30	70	100
3	PC	23APC0306	Manufacturing processes	2	1	0	3	30	70	100
4	PC	23APC0307	Fluid Mechanics & Hydraulic Machines	2	1	0	3	30	70	100
5	PC	23APC0308	Theory of Machines	2	1	0	3	30	70	100
6	PC	23APC0309	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5	30	70	100
7	PC	23APC0310	Manufacturing processes Lab	0	0	3	1.5	30	70	100
8	SC	23ASC9901	Soft Skills	0	1	2	2	30	70	100
9	ES	23AES0304	Design Thinking & Innovation	0	1	2	2	30	70	100
10	MC	23AMC9901	Environmental Science	2	0	0	-	30	-	30
Total				12	6	10	21	300	630	930



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MECHANICAL ENGINEERING (ME)
B. Tech – III Year I Semester

AK23 Regulations

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	PC	23APC0311	Machining Process	2	1	0	3	30	70	100
2	PC	23APC0312	Thermal Engineering	2	1	0	3	30	70	100
3	PC	23APC0313	Metrology and Measurements	2	1	0	3	30	70	100
4	PE-I	23APE0301	Tool Design	2	1	0	3	30	70	100
		23APE0302	Automobile Engineering							
		23APE0303	Mechanical behaviour of Materials							
		23APE0304	Work study and Ergonomics							
		23APE0305	Nano Technology							
5	OE-I		Open Elective - I	2	1	0	3	25	75	100
6	MC	23AES0504	Introduction to Quantum Technology & Applications	2	1	0	3	30	70	100
7	PC	23APC0314	Thermal Engineering Lab	0	0	3	1.5	30	70	100
8	PC	23APC0315	Dynamics lab	0	0	3	1.5	30	70	100
9	SC	23ASC0301	Skill Enhancement course Machine Tools & Metrology lab	0	1	2	2	30	70	100
10	ES	23AES0404	Tinkering Lab	0	0	2	1	30	70	100
11	PR	23APR0301	Evaluation of Community Service Internship	-	-	-	2	100	-	100
Total				12	7	10	26	395	705	1100

Open Elective – I

S.No.	Course Code	Course Name	Offered by the Dept.
1	23AOE0101	Green Buildings	CIVIL
2	23AOE0102	Construction Technology and Management	
3	23AOE0201	Electrical Safety Practices and Standards	EEE
4	23AOE0401	Electronic Circuits	ECE
5	23AOE0501	Java Programming	CSE & Allied/IT
6	23AOE0402	Introduction to Artificial Intelligence	
7	23AOE0503	Quantum Technologies and Applications	
8	23AOE9901	Mathematics for Machine Learning and AI	Mathematics
9	23AOE9906	Materials Characterization Techniques	Physics
10	23AOE9911	Chemistry of Energy Systems	Chemistry
11	23AOE9915	English for Competitive Examinations	Humanities
12	23AOEMB01	Entrepreneurship and New Venture Creation	

Note: 1. A student is permitted to register for Honors or a Minor in IV semester after the results of III Semester are declared and students may be allowed to take maximum two subjects per semester pertaining to their Minor from V Semester onwards.

2. A student shall not be permitted to take courses as Open Electives/Minor/Honors with content substantially equivalent to the courses pursued in the student's primary major.

3. A student is permitted to select a Minor program only if the institution is already offering a Major degree program in that discipline.



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B. Tech – III Year II Semester

AK23 Regulations

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	PC	23APC0316	Heat Transfer	2	1	0	3	30	70	100
2	PC	23APC0317	CAD/CAM	2	1	0	3	30	70	100
3	PC	23APC0318	Design of Machine Members	2	1	0	3	30	70	100
4	PE-II	23APE0306	Engineering Fracture Mechanics	2	1	0	3	30	70	100
		23APE0307	Introduction of Turbo Machinery							
		23APE0308	Control Systems							
		23APE0309	Operations Research							
		23APE0310	Smart Materials							
5	PE-III	23APE0311	Applications of Computational Fluid dynamics	2	1	0	3	30	70	100
		23APE0312	Industrial Safety							
		23APE0313	Design of Automobile Transmission Systems							
		23APE0314	Mechanics & Manufacturing of Composite Materials							
		23APE0315	Introduction to hybrid and electric vehicles							
6	OE-II		Open Elective-II	2	1	0	3	25	75	100
7	PC	23APC0319	Heat Transfer Lab	0	0	3	1.5	30	70	100
8	PC	23APC0320	CAD/CAM Lab	0	0	3	1.5	30	70	100
9	SC	23A SC0302	Skill oriented course 3D Printing Lab	0	1	2	2	30	70	100
10	MC	23AMC9902	Mandatory non-credit course Technical paper writing and IPR	2	0	0	-	30	-	30
11	SC	23ASC0303	WORKSHOP	-	-	-	-	-	-	-
Total				14	7	08	23	295	635	930
Mandatory Industry Internship of 6-8 weeks duration during summer vacation										

NOTE: Workshop can be conducted either III Year I semester or III Year II semester and the participation certificate with 90% and above attendance on it shall be submitted to department/ exam branch before III Year II semester regular examination notification is released.



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Open Elective – II

S.No.	Course Code	Course Name	Offered by the Dept.
1	23AOE0103	Disaster Management	CIVIL
2	23AOE0104	Sustainability in Engineering Practices	
3	23AOE0202	Renewable Energy Sources	EEE
4	23AOE0402	Digital Electronics	ECE
5	23AOE0504	Operating Systems	CSE & Allied/IT
6	23AOE0505	Machine Learning	
7	23AOE9902	Optimization Techniques	Mathematics
8	23AOE9903	Mathematical Foundation of Quantum Technologies	
9	23AOE9907	Physics of Electronic Materials and Devices	Physics
10	23AOE9912	Chemistry of Polymers and Applications	Chemistry
11	23AOE9916	Academic Writing and Public Speaking	Humanities



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B. Tech – IV Year I Semester

AK23 Regulations

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	PC	23APC0321	AI & ML for Mechanical Engineering	2	1	0	3	30	70	100
2	HM	23AHMMB04	Business Ethics and Corporate Governance	2	0	0	2	30	70	100
		23AHMMB05	E-Business							
		23AHMMB06	Management Science							
3	PE-IV	23APE0316	Mechanical Vibrations	2	1	0	3	30	70	100
		23APE0317	Finite Element Methods							
		23APE0318	Refrigeration & Air Conditioning							
		23APE0319	Mechatronics & MEMS							
		23APE0320	Power Plant Engineering							
4	PE-V	23APE0321	Non-Conventional Energy Sources	2	1	0	3	30	70	100
		23APE0322	Automation & Robotics							
		23APE0323	Non-Destructive Testing							
		23APE0324	Total Quality Management							
		23APE0325	Smart Manufacturing							
5	OE-III		Open Elective-III	2	1	0	3	25	75	100
6	OE-IV		Open Elective-IV	2	1	0	3	25	75	100
7	SC	23ASC0406	Skill Enhancement Course Introduction to Drone Technology	0	1	2	2	30	70	100
8	MC	23AMCMB01	Gender Sensitization	2	0	0	-	30	-	30
9	PR	23APR0302	Evaluation of Industry Internship (Short Term)	-	-	-	2	100	-	100
Total				14	6	2	21	330	500	830

Open Elective – III

S.No.	Course Code	Course Name	Offered by the Dept.
1	23AOE0105	Building Materials and Services	CIVIL
2	23APE0103	Environmental Impact Assessment	
3	23AOE0203	Smart Grid Technologies	EEE
4	23APC0412	Microprocessors and Microcontrollers	ECE
5	23AOE0506	Data Base Management Systems	CSE & Allied/IT
6	23AOE0507	Cyber Security	
7	23AOE9904	Wavelet transforms and its applications	Mathematics
8	23AOE9908	Smart Materials and Devices	Physics
9	23AOE9909	Introduction to Quantum Mechanics	
10	23AOE9913	Green Chemistry and Catalysis for Sustainable Environment	Chemistry
11	23AOE9917	Employability Skills	Humanities



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Open Elective – IV

S.No.	Course Code	Course Name	Offered by the Dept.
1	23AOE0106	Geo-Spatial Technologies	CIVIL
2	23AOE0107	Solid Waste Management	
3	23AOE0204	Electric Vehicles	EEE
4	23AOE0403	Transducers and Sensors	ECE
5	23AOE0508	Computer Networks	CSE & Allied/IT
6	23AOE0509	Internet of Things	
7	23AOE0510	Quantum Computing	
8	23AOE9905	Financial Mathematics	Mathematics
9	23AOE9910	Sensors and Actuators for Engineering Applications	Physics
10	23AOE9914	Chemistry of Nanomaterials and Applications	Chemistry
11	23AOE9918	Literary Vibes	Humanities

B. Tech – IV Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	PR	23APR0303	Industry Internship (Long Term)	-	-	12	4	100	-	100
2	PR	23APR0304	Project Work	-	-	12	8	60	140	200
Total				-	-	24	12	-	-	300



B.Tech with HONOURS Degree in Mechanical Engineering

Eligibility for registrations for Honors degree program:

- Student should have pass first three semesters with average CGPA of 7.0 without any backlogs in between semester will be considered in the end of IV semester and will be registered.
- For getting the HONOURS degree student needs to choose any six courses from the below list to get 18 credits related to HONOURS degree course in addition to 163 credits. Hence after completion of above structure, student needs to submit NPTEL certification proofs for 18 credits to the respective department.

List of courses offered for HONOURS Degree in Mechanical Engineering

S.No	Course Name	Weeks	Credits
1	Supply chain Management	12weeks	3
2	Sustainable energy technology	12weeks	3
3	Advanced Dynamics	12weeks	3
4	Engineering fracture mechanics	12weeks	3
5	Finite Element Method: Variational Methods to Computer Programming	12weeks	3
6	Advanced Materials and Processes	12weeks	3
7	Robotics: basics and selected advanced concepts	12weeks	3
8	Automation in manufacturing	12weeks	3
9	Energy Conservation and Waste Heat Recovery	12weeks	3
10	Design of Mechatronic Systems	12weeks	3
11	Metal Additive Manufacturing	12weeks	3
12	Mathematical Modeling Of Manufacturing Processes	12weeks	3



B.Tech with MINORS Degree

Eligibility for registrations for Minors degree program:

- Student should have pass first three semesters with average CGPA of 7.0 without any backlogs in between semester will be considered in the end of IV semester and will be registered.
- For getting the MINORS degree student needs to choose any five courses from the below list to get 15 credits for remaining 3 credits student needs to submit a project work related to MINORS degree course in addition to 163 credits. Hence after completion of above structure, student needs to submit NPTEL certification proofs and project proofs for 18 credits to the respective department.

B.Tech with MINORS Degree in 3D Printing to CIVIL,EEE,ECE,CSE,CSD,CIC,AIDS,AIIML branches offered by Mechanical Engineering

List of courses offered in 3D Printing MINORS Degree

S.No	Course Name	Weeks	Credits
1	Material Processing (Metallurgical Aspects): Fundamental, and Practical	12weeks	3
2	Fundamentals of Manufacturing Processes	12weeks	3
3	Fundamentals of Additive Manufacturing Technologies	12weeks	3
4	Rapid Manufacturing	12weeks	3
5	Fundamentals of Conduction and Radiation	12weeks	3
6	Product design and manufacturing	12weeks	3
7	Basics of Materials Engineering	12weeks	3
8	Introduction to Composites	12weeks	3
9	Engineering Graphics and Design	12weeks	3
10	Mechanical Behavior of Materials	12weeks	3

B.Tech with MINORS Degree in Industrial Engineering to CIVIL,EEE,ECE,CSE,CSD,CIC,AIDS,AIIML branches offered by Mechanical Engineering

List of courses offered in Industrial Engineering MINORS Degree

S.No	Course Name	weeks	Credits
1	Material Processing (Metallurgical Aspects): Fundamental, and Practical	12weeks	3
2	Fundamentals of Manufacturing Processes	12weeks	3
3	Industrial Safety Engineering	12weeks	3
4	Principles of Industrial Engineering	12weeks	3
5	Industrial Engineering	12weeks	3
6	Operations Management	12weeks	3
7	Quality Design and Control	12weeks	3
8	Operations and supply chain management	12weeks	3
9	Basics of materials engineering	12weeks	3
10	Automation in manufacturing	12weeks	3



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				L	T/C LC	P				
1	BS	23ABS9903	Engineering Physics	2	1	0	3	30	70	100
2	BS	23ABS9904	Linear Algebra & Calculus	2	1	0	3	30	70	100
3	ES	23AES0201	Basic Electrical & Electronics Engineering	2	1	0	3	30	70	100
4	ES	23AES0301	Engineering Graphics	1	0	4	3	30	70	100
5	ES	23AES0501	Introduction to Programming	2	1	0	3	30	70	100
6	ES	23AES0503	IT Workshop	0	0	2	1	30	70	100
7	BS	23ABS9908	Engineering Physics Lab	0	0	2	1	30	70	100
8	ES	23AES0202	Electrical & Electronics Engineering Workshop	0	0	3	1.5	30	70	100
9	ES	23AES0502	Computer Programming Lab	0	0	3	1.5	30	70	100
10	HM	23AHM9904	NSS/NCC/Scouts & Guides/Community Service	-	-	1	0.5	50	-	50
Total				9	4	15	20.5	320	630	950



Year: I

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ABS9903	Engineering Physics	2	1	0	3

Course Outcomes:

- CO: 1 Understand the intensity variation of light due to interference, diffraction, and polarization.
- CO: 2 Analyze the fundamentals of crystallography and X-ray diffraction.
- CO: 3 Apply the basic concepts of dielectric and magnetic materials for engineering applications.
- CO: 4 Analyze the fundamentals of Quantum mechanics and interpret the nanomaterials for engineering problems.
- CO: 5 Analyze the charge carrier dynamics in semiconductors by implementing the equations of state

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The intensity variation of light due to interference, diffraction, and polarization.			L2
CO2	Analyze	The fundamentals of crystallography and X-ray diffraction.			L4
CO3	Apply	The basic concepts of dielectric and magnetic materials		for engineering applications.	L3
CO4	Analyze	The fundamentals of Quantum mechanics and interpret the nanomaterials		for engineering problems.	L4
CO5	Analyze	The charge carrier dynamics in semiconductors.	by implementing the equations of state.		L4

Unit I:

Interference: Introduction - Principle of superposition –Interference of light - Interference in thin films (Reflection Geometry) & applications - Newton's Rings, Determination of wavelength and refractive index. Diffraction: Introduction - Fresnel and Fraunhofer diffractions - Fraunhofer diffraction due to single slit, double slit (Qualitative) – Diffraction Grating. Polarization: Introduction -Types of polarization - Polarization by reflection, refraction and Double refraction - Nicol's Prism -Half wave and Quarter wave plates.

Unit II

Crystallography: Space lattice, Basis, Unit Cell and lattice parameters – Bravais Lattices – crystal systems (3D) – coordination number - packing fraction of SC, BCC & FCC - Miller indices – separation between successive (hkl) planes. X-ray diffraction: Bragg's law - X-ray Diffractometer – crystal structure determination by Laue's and powder methods.

Unit III

Dielectric Materials: Introduction - Dielectric polarization - Dielectric polarizability, Susceptibility, Dielectric constant and Displacement Vector – Relation between the electric vectors - Types of polarizations- Electronic (Quantitative), Ionic (Quantitative) and Orientation polarizations (Qualitative) - Lorentz internal field - Clausius- Mossotti equation - Frequency dependence of polarization Applications of Dielectric materials.

Magnetic Materials: Introduction - Magnetic dipole moment - Magnetization-Magnetic susceptibility and permeability – Atomic origin of magnetism - Classification of magnetic materials: Dia, para, Ferro, anti-ferro & Ferri magnetic materials - Domain concept for Ferromagnetism & Domain walls (Qualitative) - Hysteresis - soft and hard magnetic materials - Applications of magnetic materials.



Unit IV

Quantum Mechanics: Dual nature of matter – Heisenberg’s Uncertainty Principle – Significance and properties of wave function – Schrodinger’s time independent and dependent wave equations– Particle in a one-dimensional infinite potential well.

Nanomaterials: Introduction to Nanomaterials–Significance of nanoscale - Physical, Mechanical, Magnetic, and optical properties of nanomaterials –Synthesis of nanomaterials: Ball Milling, Applications of Nanomaterials.

Unit V

Semiconductors: Formation of energy bands – classification of crystalline solids - Intrinsic semiconductors: Density of charge carriers – Electrical conductivity – Fermi level – Extrinsic semiconductors: density of charge carriers – dependence of Fermi energy on carrier concentration and temperature - Drift and diffusion currents – Einstein’s equation – Hall effect and its applications – Applications of semiconductors.

Text Books:

1. A Text book of Engineering Physics, M. N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy, S. Chand Publications, 11th Edition 2019.
2. K.Thyagarajan “Engineering Physics”, -Mc Graw Hill Publishing Company Ltd, 2016.
3. Engineering Physics - D.K.Bhattacharya and Poonam Tandon, Oxford press (2015).

Reference Books:

1. Engineering Physics - B.K. Pandey and S. Chaturvedi, Cengage Learning 2021.
2. Engineering Physics - Shatendra Sharma, Jyotsna Sharma, Pearson Education, 2018.
3. Engineering Physics” - Sanjay D. Jain, D. Sahasrabudhe and Girish, University Press.2010
4. Engineering Physics - M.R. Srinivasan, New Age international publishers (2009).

Web Resources:

- <https://www.loc.gov/rr/scitech/selected-internet/physics.html>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Engineering Physics	CO1	3												
	CO2	3												
	CO3	3			3									
	CO4	3												
	CO5	3			3									

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	15	22.3	3	Understand	L2	PO1	PO1: Apply (L3)	2
2	11	16.4	2	Analyze	L4	PO1	PO1: Apply (L3)	3
3	12	17.9	2	Apply	L3	PO1, PO4	PO1, PO4: Apply (L3)	3
4	13	19.4	2	Analyze	L4	PO1	PO1: Apply (L3)	3
5	16	23.8	3	Analyze	L4	PO1, PO4	PO1, PO4: Apply (L3)	3
Total	67							



Justification Statements:

CO1: The intensity variation of light due to interference, diffraction, and polarization.

Action Verb: Understand (L2)

PO1 Verbs: Apply (L3)

CO1 Action Verb is lesser than PO1 verb by one level; Therefore, correlation is moderate (2).

CO2: The fundamentals of crystallography.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO2 Action Verb is greater than PO1 verb; Therefore correlation is high (3).

CO3: Apply the basic concepts of dielectric and magnetic materials for engineering applications.

Action Verb: Apply (L3)

PO1 and PO4 Verbs: Apply (L3)

CO3 Action Verb level is equal to PO1 and PO4 verb; Therefore correlation is high (3).

CO4: The fundamentals of Quantum mechanics and interpret the nanomaterials for engineering problems.

Action Verb: Analyze (L4)

PO1 Verb: Apply (L3)

CO4 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

CO5: The charge carrier dynamics in semiconductors by implementing the equations of state.

Action Verb: Analyze (L4)

PO1 and PO4 Verb: Apply (L3)

CO5 Action verb is greater than PO1 verb; therefore, the correlation is high (3).



Year: I

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ABS9904	Linear Algebra and Calculus	2	1	0	3

Course Outcomes:

- CO: 1 Analyze the matrix algebraic techniques for engineering applications.
 CO: 2 Understand the concept of Eigen values, Eigen vectors and quadratic forms.
 CO: 3 Analyze the mean value theorems for real time applications.
 CO: 4 Apply the concepts of partial differentiation to functions of several variables.
 CO: 5 Apply the multivariable integral calculus for computation of Area and Volume.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the matrix algebraic techniques	for engineering applications.		L4
CO2	Understand	the concept of eigen values, eigen vectors and quadratic forms.			L2
CO3	Analyze	the mean value theorems	for real time applications.		L4
CO4	Apply	the concept of Maxima and Minima	to functions of several variables.		L3
CO5	Apply	the multivariable integral calculus	for computation of Area and volume.		L3

Unit I:

Matrices

Rank of a matrix by Echelon form, Normal form, Cauchy-Binet formula (without proof). Inverse of Non-singular matrices by Gauss-Jordan method, system of linear equations: solving system of Homogeneous and Non-homogeneous equations by Gauss Elimination method, Jacobi and Gauss Seidel Iteration methods.

Unit II

Eigen values, Eigen vectors and Orthogonal Transformation

Eigen values, Eigen vectors and their properties, Diagonalization of a matrix, Cayley-Hamilton theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton theorem, Quadratic forms and Nature of the Quadratic forms, Reduction of quadratic form to canonical forms by Orthogonal Transformation.

Unit III

Calculus

Mean Value Theorems: Rolle's theorem, Lagrange's mean value theorem with their geometrical interpretation, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders (without proof), problems and applications on the above theorems.

Unit IV

Partial differentiation and Applications (Multi Variable Calculus)

Functions of several variables: Continuity and Differentiability, Partial derivatives, total derivatives, chain rule, Directional derivative, Taylor's and Maclaurin's series expansion of functions of two variables, Jacobians, Functional dependence, Maxima and Minima of functions of two variables, method of Lagrange multipliers.



Unit V

Multiple Integrals

Double integrals, triple integrals change of order of integration, change of Variables to polar, Cylindrical and Spherical coordinates, Finding areas (by double integrals) and volumes (by double integrals and triple integrals).

Text Books:

1. B. S. Grewal, Higher Engineering Mathematics, 44/e, Khanna Publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10/e, John Wiley & Sons, 2011.

Reference Books:

1. Thomas Calculus, George B. Thomas, Maurice D. Weir and Joel Hass, Pearson Publishers, 2018, 14th Edition.
2. Advanced Engineering Mathematics, R. K. Jain and S. R. K. Iyengar, Alpha Science International Ltd., 25th Edition (9th reprint).
3. Advanced Modern Engineering Mathematics, Glyn James, Pearson publishers, 2018, 5th Edition.
4. Advanced Engineering Mathematics, Micheael Greenberg, Pearson publishers, 9th edition.
5. Higher Engineering Mathematics, H. K Das, Er. Rajnish Verma, S. Chand Publications, 2014, Third Edition (Reprint 2021).

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Linear Algebra and Calculus	CO1		3											
	CO2		2											
	CO3		3											
	CO4	3												
	CO5	3												

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	10	14	2	Analyze	L4	PO2	Analyze	3
2	15	21.4	3	Understand	L2	PO2	Apply	2
3	15	21.4	3	Analyze	L4	PO2	Analyze	3
4	16	22.8	3	Apply	L3	PO1	Apply	3
5	14	20	3	Apply	L3	PO1	Apply	3
Total	70							

Justification Statements:

CO1: Analyze the matrix algebraic techniques that are needed for engineering applications.

Action Verb: Analyze(L4)

PO2 Verbs: Analyze (L4)

CO1 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).

CO2: Understand the concept of eigen values, eigen vectors and quadratic forms.



Action Verb: Understand (L2)

PO1 Verbs: Apply (L3)

CO2 Action Verb is low level to PO1 verb by one level; Therefore, correlation is moderate (2).

CO3: Analyze the mean value theorems for real life problems.

Action Verb: Analyze (L4)

PO1 Verb: Analyze (L4)

CO3 Action Verb level is equal to PO2 verb; Therefore, correlation is high (3).

CO4: Apply the concept of Maxima and Minima of functions of several variables.

Action Verb: Apply (L3)

PO2 Verb: Apply (L3)

CO4 Action Verb level is equal to PO1 verb; Therefore, correlation is high (3).

CO5: Apply the multivariable integral calculus for computation of area and volume.

Action Verb: Apply(L3)

PO1 Verb: Apply (L3)

CO5 Action verb is high level to PO1 verb; therefore, the correlation is high (3).



Year: I

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0201	Basic Electrical & Electronics Engineering	2	1	0	3

Part – A

Course Outcomes:

- CO: 1 Understand the fundamental laws of A. C circuits and D. C circuits.
CO: 2 Understand operating principles of motors, generators and measuring instruments.
CO: 3 Understand the fundamentals of power generation, costing and safety measures

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The fundamentals laws of A. C circuits and D. C circuits.		A. C circuits and D. C circuits	L2
CO2	Understand	Operating principles of motors, generators and measuring instruments.			L2
CO3	Understand	The fundamentals of Power generation, costing and safety measures.			L2

Unit I:

DC & AC Circuits

DC Circuits: Electrical circuit elements (R, L and C), Ohm's Law and its limitations, KCL & KVL, series, parallel, series-parallel circuits, Super Position theorem, Simple numerical problems.

AC Circuits: A.C. Fundamentals: Equation of AC Voltage and current, waveform, time period, frequency, amplitude, phase, phase difference, average value, RMS value, form factor, peak factor, Voltage and current relationship with phasor diagrams in R, L, and C circuits, Concept of Impedance, Active power, reactive power and apparent power, Concept of power factor (Simple Numerical problems).

Unit II

Machines and Measuring Instruments

Machines: Construction, principle and operation of (i) DC Motor, (ii) DC Generator, (iii) Single Phase Transformer, (iv) Three Phase Induction Motor and (v) Alternator, Applications of electrical machines.

Measuring Instruments: Construction and working principle of Permanent Magnet Moving Coil (PMMC), Moving Iron (MI) Instruments and Wheat Stone Bridge.

Unit III

Energy Resources, Electricity Bill & Safety Measures

Energy Resources: Conventional and non-conventional energy resources; Layout and operation of various Power Generation systems: Hydel, Nuclear, Solar & Wind power generation.

Electricity bill: Power rating of household appliances including air conditioners, PCs, Laptops, Printers, etc. Definition of "unit" used for consumption of electrical energy, two-part electricity tariff, calculation of electricity bill for domestic consumers.

Equipment Safety Measures: Working principle of Fuse and Miniature circuit breaker (MCB), merits and demerits. Personal safety measures: Electric Shock, Earthing and its types, Safety Precautions to avoid shock.

Text Books:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013.
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition.



Reference Books:

1. Basic Electrical Engineering, D. P. Kothari and I. J. Nagrath, Mc Graw Hill, 2019, Fourth Edition.
2. Principles of Power Systems, V.K. Mehtha, S. Chand Technical Publishers, 2020.
3. Basic Electrical Engineering, T. K. Nagsarkar and M. S. Sukhija, Oxford University Press, 2017.
4. Basic Electrical and Electronics Engineering, S. K. Bhattacharya, Person Publications, 2018, Second Edition.

Web Resources:

1. <https://nptel.ac.in/courses/108105053>
2. <https://nptel.ac.in/courses/108108076>

Part – B

Course Outcomes:

- CO: 4 Understand the fundamental concepts of diodes, transistors and its applications.
CO: 5 Analyze the concepts of rectifiers, power supplies and amplifiers in electronics.
CO: 6 Analyze the concepts of Number Systems, Boolean Functions, Logic Gates and Digital Circuits

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	fundamental concepts of diodes, transistors and its applications			L2
CO2	Analyze	concepts of rectifiers, power supplies and amplifiers in electronics			L4
CO3	Analyze	concepts of Number Systems, Boolean Functions, Logic Gates and Digital Circuits			L4

Unit I:

Semiconductor Devices

Introduction - Evolution of electronics – Vacuum tubes to nano electronics - Characteristics of PN Junction Diode — Zener Effect — Zener Diode and its Characteristics. Bipolar Junction Transistor — CB, CE, CC Configurations and Characteristics — Elementary Treatment of Small Signal CE Amplifier.

Unit II

Basic Electronic Circuits and Instrumentation

Rectifiers and power supplies: Block diagram description of a DC power supply, working of a full wave bridge rectifier, capacitor filter (no analysis), working of simple Zener voltage regulator. Amplifiers: Block diagram of Public Address system, Circuit diagram and working of common emitter (RC coupled) amplifier with its frequency response. Electronic Instrumentation: Block diagram of an electronic instrumentation system.

Unit III

Digital Electronics

Overview of Number Systems, Logic gates including Universal Gates, BCD codes, Excess-3 code, Gray code, Hamming code. Boolean Algebra, Basic Theorems and properties of Boolean Algebra, Truth Tables and Functionality of Logic Gates – NOT, OR, AND, NOR, NAND, XOR and XNOR. Simple combinational circuits–Half and Full Adder, Introduction to sequential circuits, Flip flops, Registers and counters (Elementary Treatment only).



Text Books:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009.

Reference Books:

1. R. S. Sedha, A Textbook of Electronic Devices and Circuits, S. Chand & Co, 2010.
2. Santiram Kal, Basic Electronics- Devices, Circuits and IT Fundamentals, Prentice Hall, India, 2002.
3. R. T. Paynter, Introductory Electronic Devices & Circuits – Conventional Flow Version, Pearson Education, 2009.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Engineering Physics	CO1	2	2				1							
	CO2	2	1				1							
	CO3	2	1				2							
	CO4	2	3											
	CO5	3	3											
	CO6	3	3											

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	08	30	3	Understand	L2	PO1, PO2, PO6	PO1: Apply (L3) PO2: Identify (L3) PO6: Thumb Rule	2 2 1
2	08	30	3	Understand	L2	PO1, PO2, PO6	PO1: Apply (L3) PO2: Analyze(L4) PO6: Thumb Rule	2 1 1
3	10	38	3	Understand	L2	PO1, PO2, PO6	PO1: Apply (L3) PO2: Analyze(L4) PO6: Thumb Rule	2 1 2
4	08	30	3	Understand	L2	PO1, PO2	PO1: Apply (L3) PO2: Review (L2)	2 3
5	08	30	3	Analyze	L4	PO1, PO2	PO1: Apply (L3) PO2: Review (L2)	3 3
6	10	38	3	Analyze	L4	PO1, PO2	PO1: Apply(L3) PO2: Review (L2)	3 3
Total	52							

Justification Statements:

CO1: Understand the fundamental laws of AC and DC circuits.

Action Verb: Understand (L2)

PO1: Apply (L3)

CO1 Action Verb is Less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2: Identify (L3)

CO1 Action Verb is Less than PO2 verb by one level; Therefore, correlation is moderate (2).

PO6: Using thumb rule, CO1 correlates PO6 as low (1).

CO2: Understand operating principles of motors, generators, MC and MI instruments.

Action Verb: Understand (L2)

PO1: Apply (L3)

CO2 Action Verb is Less than PO1 verb by one level; Therefore, correlation is moderate (2).



Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

PO2: Analyze (L4)

CO2 Action Verb is Less than PO2 verb by two level; Therefore, correlation is low (1).

PO6: Using thumb rule, CO2 correlates PO6 as low (1).

CO3: Understand the fundamentals of power generation, costing and safety measures.

Action Verb: Understand (L2)

PO1: Apply (L3)

CO3 Action Verb is Less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2: Analyze (L4)

CO3 Action Verb is Less than PO2 verb by two level; Therefore, correlation is low (1).

PO6: Using thumb rule, CO3 correlates PO6 as medium (2).

CO4: Understand the fundamental concepts of diodes, transistors and its applications

Action Verb: Understand (L2)

PO1 Verbs: Apply (L3)

CO4 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2 Verbs: Review (L2)

CO4 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).

CO5: Analyze the concepts of rectifiers, power supplies and amplifiers in electronics.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO5 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

PO2 Verbs: Review (L2)

CO5 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).

CO6: Analyze the concepts of Number Systems, Boolean Functions, Logic Gates and Digital Circuits.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO6 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

PO2 Verbs: Review (L2)

CO6 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).



Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0301	Engineering Graphics	1	0	4	3

Course Outcomes:

- CO: 1 Apply the concepts of engineering curves and scales for technical drawing.
 CO: 2 Understand the quadrant system to locate the position of points, lines and planes.
 CO: 3 Analyze the projection of solids located in quadrant system.
 CO: 4 Analyze the sectional views and development of surfaces of regular solids.
 CO: 5 Apply orthographic and isometric projections concepts to construct the given object

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the concepts of engineering curves and scales		for technical drawing	L3
CO2	Understand	the quadrant system to locate the position of points, lines and planes			L2
CO3	Analyze	the projection of solids		located in quadrant system	L4
CO4	Analyze	the sectional views and development of surfaces		of regular solids	L4
CO5	Apply	orthographic and isometric projections concepts to construct the given object			L3

Unit I: Introduction: Lines, Lettering and Dimensioning, Geometrical Constructions and Constructing regular polygons by general methods.

Curves: construction of ellipse, parabola and hyperbola by general, Cycloids, Involute, Normal and tangent to Curves.

Scales: Plain scales, diagonal scales and vernier scales.

Unit II

Orthographic Projections: Reference plane, importance of reference lines or Plane, Projections of a point situated in any one of the four quadrants.

Projections of Straight Lines: Projections of straight lines parallel to both reference planes, perpendicular to one reference plane and parallel to other reference plane, inclined to one reference plane and parallel to the other reference plane. Projections of Straight Line Inclined to both the reference planes

Projections of Planes: regular planes Perpendicular to both reference planes, parallel to one reference plane and inclined to the other reference plane; plane inclined to both the reference planes.

Unit III

Projections of Solids: Types of solids: Polyhedra and Solids of revolution. Projections of solids in simple positions: Axis perpendicular to horizontal plane, Axis perpendicular to vertical plane and Axis parallel to both the reference planes, Projection of Solids with axis inclined to one reference plane and parallel to another plane.



Unit IV

Sections of Solids: Perpendicular and inclined section planes, Sectional views and True shape of section, Sections of solids in simple position only.

Development of Surfaces: Methods of Development: Parallel line development and radial line development. Development of a cube, prism, cylinder, pyramid and cone.

Unit V

Conversion of Views: Conversion of isometric views to orthographic views; Conversion of orthographic views to isometric views. **Computer graphics:** Creating 2D&3D drawings of objects including PCB and Transformations using Auto CAD (*Not for end examination*).

Text Books:

1. K. L. Narayana & P. Kannaiah, Engineering Drawing, 3/e, Scitech Publishers
2. N. D. Bhatt, Engineering Drawing, 53/e, Charotar Publishers

Reference Books:

1. Engineering Drawing, K.L. Narayana and P. Kannaiah, Tata McGraw Hill, 2013.
2. Engineering Drawing, M.B. Shah and B.C. Rana, Pearson Education Inc, 2009.
3. Engineering Drawing with an Introduction to AutoCAD, Dhananjay Jolhe, Tata McGraw Hill, 2017.

Articulation Matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Engineering Graphics	CO1	3		3						3			2	2
	CO2	2		2						3			2	2
	CO3	2		2									2	2
	CO4	3		3		3							2	2
	CO5	3		3		3				3			2	2

4. (Levels of Correlation, viz., 1-Low, 2-Moderate, 3-High)

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18	24	3	Apply	L3	PO1 PO3 PO9	Apply (L3) Develop (L3) Thumb Rule	3 3 1
2	15	20	2	Understand	L2	PO1 PO3 PO9	Apply (L3) Develop (L3) Thumb Rule	2 2 1
3	15	20	2	Analyze	L4	PO1 PO3 PO9	Apply (L3) Develop (L3) Thumb Rule	3 3 1
4	15	20	2	Analyze	L4	PO1 PO3 PO9	Apply (L3) Develop (L3) Thumb Rule	3 3 1
5	12	16	2	Apply	L3	PO1 PO3 PO9	Apply (L3) Develop (L3) Thumb Rule	3 3 1



Justification Statements:

CO1: Apply the concepts of engineering curves for technical drawing

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule (TR)

CO1: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO2: Understand the quadrant system to locate the position of points and projection of lines.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO2: Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: **Develop (L3)**

CO2: Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

PO9 Verb: Thumb Rule (TR)

CO2: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO3: Analyze the projection of planes as well as solids located in quadrant system.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule (TR)

CO3: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO4: Analyze the sectional views and development of surfaces of regular solids

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule (TR)

CO4: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)

CO5: Apply orthographic and isometric projections concepts to construct the given object.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO5: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO5: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule (TR)

CO5: Engineering graphics involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3)



Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0501	Introduction To Programming (Common to All branches of Engineering)	2	1	0	3

Course Outcomes:

- CO: 1 Understand the computer Programming concepts and Algorithms.
CO: 2 Analyze the control structures to implement basic programs.
CO: 3 Understand the concept of Arrays and string to manipulate the stored data.
CO: 4 Create the dynamic memory allocation using pointers and structures.
CO: 5 Create the user defined functions and files for modifying stored data

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the computer Programming concepts and Algorithms.			L2
CO2	Analyze	the control structures		to implement basic programs.	L4
CO3	Understand	the concept of Arrays and string		to manipulate the stored data	L2
CO4	Create	the dynamic memory allocation	using pointers and structures.		L6
CO5	Create	user defined functions and files		for modifying stored data.	L6

Unit I:

History of Computers, Basic organization of a computer: ALU, input-output units, memory, program counter, Introduction to Programming Languages, Basics of a Computer Program- Algorithms, flowcharts (Using Dia Tool), pseudo code. Introduction to Compilation and Execution, Primitive Data Types, Variables, and Constants, Basic Input and Output, Operations, Type Conversion, and Casting.

Problem solving techniques: Algorithmic approach, characteristics of algorithm, Problem solving strategies: Top-down approach, Bottom-up approach, Time and space complexities of algorithms.

Unit II

Control Structures: Simple sequential programs Conditional Statements (if, if-else, switch), Loops (for, while, do- while) Break and Continue.

Unit III

Arrays and Strings: Arrays indexing, memory model, programs with array of integers, two dimensional arrays, Introduction to Strings.

Unit IV

Pointers & User Defined Data types: Pointers, dereferencing and address operators, pointer and address arithmetic, array manipulation using pointers, User-defined data types-Structures and Unions.

Unit V

Functions & File Handling: Introduction to Functions, Function Declaration and Definition, Function call Return Types and Arguments, modifying parameters inside functions using pointers, arrays as parameters. Scope and Lifetime of Variables, Basics of File Handling.



Text Books:

1. "The C Programming Language", Brian W. Kernighan and Dennis M. Ritchie, Prentice- Hall, 1988
2. Schaum's Outline of Programming with C, Byron S Gottfried, McGraw-Hill Education, 1996

Reference Books:

1. Computing fundamentals and C Programming, Balagurusamy, E., McGraw-Hill Education, 2008.
2. Programming in C, Rema Theraja, Oxford, 2016, 2nd edition
3. C Programming, A Problem Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE, 3rd edition.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Introduction to Programming	CO1	2	3	2									3	
	CO2	3	3	3								2	2	
	CO3	2	3									2	2	
	CO4	3	3	3								2	2	
	CO5	3	3	3									2	2

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	19	25%	3	CO1: Understand	L2	PO1 PO2 PO3	PO1: Apply(L3) PO2: Review(L2) PO3: Develop(L3)	2 3 2
2	10	14%	2	CO2: Analyze	L4	PO1 PO2 PO3 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO3: Develop (L3) PO11: Thumb rule	3 3 3 2
3	19	25%	3	CO3: Understand	L2	PO1 PO2 PO11	PO1: Apply(L3) PO2: Review (L2) PO11: Thumb rule	2 3 2
4	15	20%	2	CO4: Create	L6	PO1 PO2 PO3 PO11	PO1: Apply(L3) PO2: Review (L2) PO3: Develop (L3) PO11: Thumb rule	3 3 3 2
5	12	16%	2	CO5: Create	L6	PO1 PO2 PO3 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO11: Thumb rule	3 3 3 3
	75	100%						

Justification Statements:

CO1: Understand the computer Programming concepts and Algorithms.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)

PO2 Verb: Review (L2)

CO1 Action verb is same as PO2 verb by two level. Therefore, the correlation is High (3)

PO3 Verb: Develop (L3)

CO1 Action verb is less than as PO2 verb by one level. Therefore, the correlation is moderate (2)



CO2: Analyze the control structures to implement basic programs.

Action Verb: Analyze (L4)

PO1: Apply (L3)

CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

CO2 Action verb is equal to PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO2 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

Some of the flow of control statements knowledge are used to solve various problems. Therefore, the correlation is moderate (2)

CO3: Understand the concept of Arrays and string to manipulate the stored data.

Action Verb: Understand (L2)

PO1: Apply (L3)

CO3 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)

PO2: Review (L2)

CO3 Action verb is Same as PO2 verb. Therefore, the correlation is High (3)

PO11: Thumb rule

For some matrix operations array and string concepts were used Therefore, the correlation is moderate (2)

CO4: Create the dynamic memory allocation using pointers and structures.

Action Verb: Create (L6)

PO1: Apply (L3)

CO4 Action verb is greater than PO1 verb by two levels. Therefore, the correlation is high (3)

PO2: Review (L2)

CO4 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO4 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some mathematical operations Pointers and structures are used to manipulate the memory references. Therefore, the correlation is moderate (2)

CO5: Create the user defined functions and files for modifying stored data.

Action Verb: Create (L6)

PO1: Apply (L3)

CO5 Action verb is greater than as PO1 verb by two levels. Therefore, the correlation is high (3)

PO2: Review (L2)

CO5 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO5 Action verb is greater than as PO3 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

In today's world file handling techniques were used in most of the areas. Therefore, the correlation is high (3)



Year: I

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0503	IT Workshop (Common to AIML, AIDS, CE, ECE & ME)	0	0	2	1

Course Outcomes:

- CO: 1 Understand The Process of Software Installation & Hardware troubleshooting.
- CO: 2 Analyze the network configurations for customizing web pages and search engines.
- CO: 3 Apply the basic editing function, formatting text & objects on a required content.
- CO: 4 Apply the formulas, functions and visualizations to manage the data.
- CO: 5 Understand the libraries and models of chatGPT to generate information

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The Process of Software Installation & Hardware troubleshooting.			L2
CO2	Analyze	the network configurations		for customizing web pages and search engines	L4
CO3	Apply	The basic editing function, formatting text & objects		on a required content	L3
CO4	Apply	the formulas, functions and visualizations		to manage the data	L3
CO5	Understand	The libraries and models of chatGPT		to generate information	L2

List of Experiments

PC Hardware & Software Installation

Task 1: Identify the peripherals of a computer, components in a CPU and its functions. Draw the block diagram of the CPU along with the configuration of each peripheral and submit to your instructor.[CO1]

Task 2: Every student should disassemble and assemble the PC back to working condition. Lab instructors should verify the work and follow it up with a Viva. Also students need to go through the video which shows the process of assembling a PC. A video would be given as part of the course content.[CO1]

Task 3: Every student should individually install MS windows on the personal computer. Lab instructor should verify the installation and follow it up with a Viva.[CO1]

Task 4: Every student should install Linux on the computer. This computer should have windows installed. The system should be configured as dual boot (VMWare) with both Windows and Linux. Lab instructors should verify the installation and follow it up with a Viva.[CO1]

Task 5: Every student should install BOSS on the computer. The system should be configured as dual boot (VMWare) with both Windows and BOSS. Lab instructors should verify the installation and follow it up with a Viva.[CO1]

Internet & World Wide Web

Task1: Orientation & Connectivity Boot Camp: Students should get connected to their Local Area Network and access the Internet. In the process they configure the TCP/IP setting. Finally students should demonstrate, to the instructor, how to access the websites and email. If there is no internet connectivity preparations need to be made by the instructors to simulate the WWW on the LAN.[CO2]



Task 2: Web Browsers, Surfing the Web: Students customize their web browsers with the LAN proxy settings, bookmarks, search toolbars and pop up blockers. Also, plug-ins like Macromedia Flash and JRE for applets should be configured.[CO2]

Task 3: Search Engines & Netiquette: Students should know what search engines are and how to use the search engines. A few topics would be given to the students for which they need to search on Google. This should be demonstrated to the instructors by the student. [CO2]

Task 4: Cyber Hygiene: Students would be exposed to the various threats on the internet and would be asked to configure their computer to be safe on the internet. They need to customize their browsers to block pop ups, block active x downloads to avoid viruses and/or worms. [CO2]

LaTeX and WORD

Task 1 – Word Orientation: The mentor needs to give an overview of La TeX and Microsoft (MS) office or equivalent (FOSS) tool word: Importance of La TeX and MS office or equivalent (FOSS) tool Word as word Processors, Details of the four tasks and features that would be covered in each, Using La TeX and word – Accessing, overview of toolbars, saving files, Using help and resources, rulers, format painter in word. [CO3]

Task 2: Using La TeX and Word to create a project certificate. Features to be covered:- Formatting Fonts in word, Drop Cap in word, Applying Text effects, Using Character Spacing, Borders and Colors, Inserting Header and Footer, Using Date and Time option in both La TeX and Word. [CO3]

Task 3: Creating project abstract Features to be covered:-Formatting Styles, Inserting table, Bullets and Numbering, Changing Text Direction, Cell alignment, Footnote, Hyperlink, Symbols, Spell Check, Track Changes. [CO3]

Task 4: Creating a Newsletter: Features to be covered:- Table of Content, Newspaper columns, Images from files and clipart, Drawing toolbar and Word Art, Formatting Images, Textboxes, Paragraphs and Mail Merge in word. [CO3]

EXCEL

Excel Orientation: The mentor needs to tell the importance of MS office or equivalent (FOSS) tool Excel as a Spreadsheet tool, give the details of the four tasks and features that would be covered in each. Using Excel – Accessing, overview of toolbars, saving excel files, Using help and resources. [CO4]

Task 1: Creating a Scheduler - Features to be covered: Gridlines, Format Cells, Summation, auto fill, Formatting Text[CO4]

Task 2: Calculating GPA -. Features to be covered:- Cell Referencing, Formulae in excel – average, std. deviation, Charts, Renaming and Inserting worksheets, Hyper linking, Count function, [CO4]
LOOKUP/VLOOKUP

Task 3: Split cells, freeze panes, group and outline, Sorting, Boolean and logical operators, Conditional formatting[CO4] POWER POINT

Task 1: Students will be working on basic power point utilities and tools which help them create basic power point presentations. PPT Orientation, Slide Layouts, Inserting Text, Word Art, Formatting Text, Bullets and Numbering, Auto Shapes, Lines and Arrows in PowerPoint. [CO4]

Task 2: Interactive presentations - Hyperlinks, Inserting –Images, Clip Art, Audio, Video, Objects, Tables and Charts. [CO4] Task 3: Master Layouts (slide, template, and notes), Types of views (basic, presentation, slide slotter, notes etc), and Inserting – Background, textures, Design Templates, Hidden slides. [CO4]



AI TOOLS – ChatGPT

Task 1: Prompt Engineering: Experiment with different types of prompts to see how the model responds. Try asking questions, starting conversations, or even providing incomplete sentences to see how the model completes them. [CO5]

- Ex: Prompt: "You are a knowledgeable AI. Please answer the following question: What is the capital of France?"

Task 2: Creative Writing: Use the model as a writing assistant. Provide the beginning of a story or a description of a scene, and let the model generate the rest of the content. This can be a fun way to brainstorm creative ideas[CO5]

- Ex: Prompt: "In a world where gravity suddenly stopped working, people started floating upwards. Write a story about how society adapted to this new reality."

Task 3: Language Translation: Experiment with translation tasks by providing a sentence in one language and asking the model to translate it into another language. Compare the output to see how accurate and fluent the translations are. [CO5]

- Ex: Prompt: "Translate the following English sentence to French: 'Hello, how are you doing today?'"

Reference Books:

1. Comdex Information Technology course tool kit, Vikas Gupta, WILEY Dream tech, 2003
2. The Complete Computer upgrade and repair book, Cheryl A Schmidt, WILEY Dream tech, 2013, 3rd edition
3. Introduction to Information Technology, ITL Education Solutions limited, Pearson Education, 2012, 2nd edition
4. PC Hardware - A Handbook, Kate J. Chase, PHI (Microsoft)
5. LaTeX Companion, Leslie Lamport, PHI/Pearson.
6. IT Essentials PC Hardware and Software Companion Guide, David Anfins on and Ken Quamme. – CISCO Press, Pearson Education, 3rd edition
7. IT Essentials PC Hardware and Software Labs and Study Guide, Patrick Regan– CISCO Press, Pearson Education, 3rd edition

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Engineering Physics	CO1	2	3										1	
	CO2	3	3	3	3	3								
	CO3	3	3	3	2	3						3	2	
	CO4	3	3	3	2	3						3		2
	CO5	2	2											1

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
1	CO1: Understand	L2	PO1 PO2	PO1: Apply(L3) PO2: Review(L2)	2 3
2	CO2: Analyze	L4	PO1	PO1: Apply(L3)	3
			PO2	PO2: Identify (L3)	3
			PO3	PO3: Develop(L3)	3
			PO4	PO4: Analyze (L4)	3
			PO5	PO5: Apply (L3)	3



MECHANICAL ENGINEERING (ME)

3	CO3: Apply	L3	PO1	PO1: Apply(L3)	3
			PO2	PO2: Review (L2)	3
			PO3	PO3: Develop(L3)	3
			PO4	PO4: Analyze (L4)	2
			PO5	PO5: Apply (L3)	3
			PO11	PO11: Thumb rule	3
4	CO4: Apply	L3	PO1	PO1: Apply(L3)	3
			PO2	PO2: Review (L2)	3
			PO3	PO3: Develop(L3)	3
			PO4	PO4: Analyze (L4)	2
			PO5	PO5: Apply (L3)	3
			PO11	PO11: Thumb rule	3
5	CO5: Understand	L2	PO1	PO1: Apply(L3)	2
			PO2	PO2: Identify (L3)	2

Justification Statements:

CO1: Understand The Process of Software Installation & Hardware

troubleshooting Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)

PO2 Verb: Review(L2)

CO1 Action verb is same as PO2 verb. Therefore, the correlation is high (3)

CO2: Analyze the network configurations for customizing web pages and search

engines Action Verb: Analyze (L4)

PO1: Apply (L3)

CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Identify(L3)

CO2 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO2 Action verb is greater than as PO3 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO2 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

PO5: Apply (L3)

CO2 Action verb is greater than as PO5 verb. Therefore, the correlation is high (3)

CO 3: Apply The basic editing function, formatting text & objects on a required content.

Action Verb: Apply

(L3) PO1: Apply (L3)

CO3 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Review(L2)

CO3 Action verb is less than as PO2 verb. Therefore, the correlation is high (3)

PO3: Develop(L3)

CO3 Action verb is same as PO3 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO3 Action verb is less than as PO4 verb. Therefore, the correlation is moderate (2)

PO5: Apply (L3)

CO3 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

Documentation and presentation is learning process to find the solution better manner the correlation is high (3)

CO 4: Apply the formulas, functions and visualizations to manage the data.

Action Verb: Apply

(L3) PO1: Apply (L3)



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

CO4 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: identify (L3)

CO4 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)

PO3: Develop (L3)

CO4 Action verb is same as PO3 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

CO4 Action verb is less than as PO4 verb by one level. Therefore, the correlation is moderate (2)

PO5: Apply (L3)

CO4 Action verb is greater than as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

Spread sheets in Excel is the trending approach in the current days Therefore, the correlation is high (3)

CO 5: Understand the libraries and models of chatGPT to generate information.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)

PO2 Verb: Identify (L3)

CO1 Action verb is same as PO2 verb. Therefore, the correlation is moderate (2)



Year: I

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ABS9908	Engineering Physics Lab	0	0	2	1

Course Outcomes:

- CO: 1 Analyze the properties of light for engineering problems.
CO: 2 Evaluate the crystallite size using X-ray diffraction.
CO: 3 Analyze the basic properties of dielectric and magnetic behavior of the given material.
CO: 4 Determine the mechanical behavior of a given material.
CO: 5 Evaluate the basic parameters of a given semiconductor material

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	The properties of light		for engineering problems.	L4
CO2	Evaluate	The crystallite size using X-ray diffraction.			L5
CO3	Analyze	The basic properties of dielectric and magnetic behavior of the given material.			L4
CO4	Determine	The mechanical behavior of a given material.			L5
CO5	Evaluate	The basic parameters of a given semiconductor material.			L5

List of Experiments:

1. Determination of radius of curvature of a given Plano-convex lens by Newton's rings – CO1.
2. Determination of wavelengths of different spectral lines in mercury spectrum using diffraction grating in normal incidence configuration – CO1.
3. Study the variation of B versus H by magnetizing the magnetic material (B-H curve) – CO3.
4. Determination of wavelength of Laser light using diffraction grating – CO1.
5. Magnetic field along the axis of a current carrying circular coil by Stewart Gee's Method – CO3.
6. Determination of energy gap of a semiconductor using p-n junction diode – CO5.
7. Determination of the resistivity of semiconductors by four probe methods – CO5.
8. Determination of the crystallite size using X-Ray Diffraction spectra – CO2.
9. Determination of the numerical aperture of a given optical fiber and angle of acceptance – CO1.
10. Verification of Brewster's law – CO1.
11. Determination of acceleration due to gravity and radius of Gyration by using a compound pendulum – CO4.
12. Determination of rigidity modulus of the material of the given wire using Torsional pendulum – CO4.
13. Determination of temperature coefficients of a thermistor – CO5.
14. Determination of dielectric constant using charging and discharging method – CO3.
15. Determination of Hall voltage and Hall coefficient of a given semiconductor using Hall Effect – CO5.
16. Sonometer: Verification of laws of stretched string – CO4.
17. Determination of magnetic susceptibility by Kundt's tube method – CO3.
18. Determination of Frequency of electrically maintained tuning fork by Melde's experiment – CO4.

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO Experiments may be conducted in virtual mode.



References: A Textbook of Practical Physics - S. Balasubramanian, M. N. Srinivasan, S. Chand Publishers, 2017.

URL: www.vlab.co.in

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
Engineering Physics Lab	CO1	1	3			3									
	CO2	2	3			3									
	CO3	3	3			3									
	CO4	4	3			3									
	CO5	5	3			3									

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	9	25	3	Analyze	L4	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3
2	6	16	2	Evaluate	L5	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3
3	9	25	3	Analyze	L4	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3
4	6	16	2	Determine	L5	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3
5	6	16	2	Evaluate	L5	PO1, PO4	PO1: Apply (L3), PO4: Analyze (L4)	3
Total	36							

Justification Statements:

CO1: Analyze the properties of light for solving engineering problems.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

PO4 Verb: Analyze (L4)

CO1 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

CO1 Action Verb is equal to PO4 verb; Therefore, correlation is high (3).

CO2: Evaluate the crystallite size using X-ray diffraction.

Action Verb: Evaluate (L5)

PO1 Verbs: Apply (L3)

PO4 Verb: Analyze (L4)

CO2 Action Verb is greater than PO1 verb by two levels; Therefore correlation is high (3).

CO2 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).

CO3: Analyze the basic properties of dielectric and magnetic behavior of the given material.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

PO4 Verb: Analyze (L4)

CO3 Action Verb level is greater than PO1 action verb by one level; Therefore correlation is high (3).

CO3 Action Verb level is equal to PO4 action verb; Therefore correlation is high (3).

CO4: Determine the mechanical behavior of a given material using dynamic methods.

Action Verb: Determine (L5)

PO1 Verbs: Apply (L3)

PO4 Verb: Analyze (L4)

CO4 Action Verb is greater than PO1 verb by two levels; Therefore correlation is high (3).

CO4 Action Verb is greater than PO4 verb by one level; Therefore correlation is high (3).



**ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
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**Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)**

MECHANICAL ENGINEERING (ME)

AK23 Regulations

CO5: Evaluate the basic parameters of a given semiconductor material.

Action Verb: Evaluate (L5)

PO1 and PO4 Verb: Apply (L3)

CO5 Action Verb is greater than PO1 verb by two levels; Therefore correlation is high (3).

CO5 Action Verb is greater than PO1 verb by one level; Therefore correlation is high (3).



Year: I

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0202	Electrical & Electronics Engineering Workshop	0	0	3	1.5

Course Outcomes:

- CO: 1 Understand the Electrical circuit design, measurement of resistance, power, and power factor.
CO: 2 Apply suitable methods to measure Resistance, power, energy and power factor.
CO: 3 Design suitable methods for magnetization characteristics of D. C shunt generator

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	Electrical circuit design; measurement of resistance, power, power factor			L2
CO2	Apply	Suitable methods to measure Resistance, power, energy and power factor.			L3
CO3	Design	Suitable methods for magnetization characteristics of D. C shunt generator.			L6

PART A
ELECTRICAL ENGINEERING LAB

List of experiments:

1. Verification of Kirchhoff's current law and Voltage law-(CO1).
2. Verification of Superposition theorem-(CO1).
3. Measurement of Resistance using Wheat stone bridge-(CO1).
4. Measurement of Power and Power factor using Single-phase watt-meter-(CO2).
5. Measurement of Earth Resistance using Megger-(CO2).
6. Calculation of Electrical Energy for Domestic Premises-(CO2).
7. Magnetization Characteristics of DC shunt Generator-(CO3).

Reference Books:

1. Basic Electrical Engineering, D. C. Kulshreshtha, Tata McGraw Hill, 2019, First Edition
2. Power System Engineering, P.V. Gupta, M.L. Soni, U.S. Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co, 2013
3. Fundamentals of Electrical Engineering, Rajendra Prasad, PHI publishers, 2014, Third Edition

Note: Minimum Six Experiments to be performed.

PART B
ELECTRONICS ENGINEERING LAB

COURSE OUTCOMES:

- CO: 1 Understand the V-I Characteristics of diodes and its applications.
CO: 2 Analyze the input and output characteristics of BJT and its applications.
CO: 3 Analyze the truth tables of all logic gates and f/f's using IC's

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	V-I Characteristics of diodes and its applications.			L2
CO2	Analyze	input and output characteristics of BJT and its applications			L4
CO3	Analyze	Truth tables of all logic gates and f/f's using IC's.			L4



List of Experiments:

1. Plot V-I characteristics of PN Junction diode A) Forward bias B) Reverse bias. (C04)
2. Plot VI characteristics of Zener Diode and its application as voltage Regulator. (C04)
3. Implementation of half wave and full wave rectifiers (C04)
4. Plot Input & Output characteristics of BJT in CE and CB configurations (C05)
5. Frequency response of CE amplifier. (C05)
6. Simulation of RC coupled amplifier with the design supplied. (C05)
7. Verification of Truth Table of AND, OR, NOT, NAND, NOR, Ex-OR, Ex-NOR gates using ICs. (C06)
8. Verification of Truth Tables of S-R, J-K& D flip flops using respective ICs. (C06)

Tools Equipment Required: DC Power supplies, Multi meters, DC Ammeters, DC Voltmeters, AC Voltmeters, CROS, and all the required active devices.

References:

1. R. L. Boylestad & Louis Nashlesky, Electronic Devices & Circuit Theory, Pearson Education, 2021.
2. R. P. Jain, Modern Digital Electronics, 4th Edition, Tata Mc Graw Hill, 2009
3. R. T. Paynter, Introductory Electronic Devices & Circuits - Conventional Flow Version, Pearson Education, 2009.

Note: Minimum Six Experiments to be performed. All the experiments shall be implemented using both Hardware and Software

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Electrical & Electronics Engineering Workshop	CO1	2	1		1					1			2	
	CO2	3	2		2					1			2	
	CO3		3		3					1			2	1
	CO4	2	3											
	CO5	3	3											
	CO6	3	3											

Correlation matrix

CO	CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Verb	BTL			
1	Understand	L2	PO1, PO2, PO4, PO9	PO1: Apply (L3) PO2: Analyze (L4) PO4: Analyze (L4) PO9: Thumb Rule	2 1 1 1
2	Apply	L3	PO1, PO2, PO4, PO9	PO1: Apply (L3) PO2: Analyze(L4) PO4: Analyze(L4) PO9: Thumb Rule	3 2 2 1
3	Design	L6	PO2, PO4, PO9	PO2: Analyze(L4) PO4: Design (L6) PO9: Thumb Rule	3 3 1
4	Understand	L2	PO1, PO2	PO1: Apply (L3) PO2: Review (L2)	2 3
5	Analyze	L4	PO1, PO2	PO1: Apply (L3) PO2: Review (L2)	3 3
6	Analyze	L4	PO1, PO2	PO1: Apply(L3) PO2: Review (L2)	3 3



Justification Statements:

CO1: Understand the Electrical circuit design, measurement of resistance, power, and power factor.

Action Verb: Understand (L2)

PO1: Apply (L3)

CO1 Action Verb is Less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2: Analyze (L4)

CO1 Action Verb is Less than PO2 verb by two level; Therefore, correlation is low (1).

PO4: Analyze (L4)

CO1 Action Verb is Less than PO4 verb by two level; Therefore, correlation is low (1).

PO9: Using Thumb Rule, CO1 correlates to PO9 as low (1).

CO2: Apply suitable methods to measure Resistance, power, energy and power factor.

Action Verb: Apply (L3)

PO1: Apply (L3)

CO2 Action Verb is same as PO1 verb; Therefore, correlation is high (3).

PO2: Analyze (L4)

CO2 Action Verb is Less than PO2 verb by one level; Therefore, correlation is moderate (2).

PO4: Analyze (L4)

CO2 Action Verb is Less than PO4 verb by one level; Therefore, correlation is moderate (2).

PO9: Using Thumb Rule, CO2 correlates to PO9 as low (1).

CO3: Design suitable methods for magnetization characteristics of D. C shunt generator.

Action Verb: Design (L6)

PO2: Analyze (L4)

CO3 Action Verb is greater than PO2 verb by two level; Therefore, correlation is high (3).

PO4: Design (L6)

CO3 Action Verb is same as PO4 verb; Therefore, correlation is high (3).

PO9: Using Thumb Rule, CO3 correlates to PO9 as low (1).

CO4: Understand the V-I Characteristics of diodes and its applications.

Action Verb: Understand (L2)

PO1 Verbs: Apply (L3)

CO4 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2)

PO2 Verbs: Review (L2)

CO4 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).

CO5: Analyze the input and output characteristics of BJT and its applications.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO5 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

PO2 Verbs: Review (L2)

CO5 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).

CO6: Analyze the truth tables of all logic gates and f/f's using IC's.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO6 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

PO2 Verbs: Review (L2)

CO6 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).



Year: I

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0502	Computer Programming Lab	0	0	3	1.5

Course Outcomes:

- CO: 1 Understand the basic syntax of C program to build applications.
CO: 2 Create the control structure for solving complex problems.
CO: 3 Apply the concepts of arrays, functions, basic concepts of pointers to organize the data.
CO: 4 Apply the concepts of structures, unions and linked list to manage heterogeneous data.
CO: 5 Create the file applications for storing and accessing data

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the basic syntax of C program		to build applications	L2
CO2	Create	the control structure		for solving complex problems	L6
CO3	Apply	the concepts of arrays, functions, basic concepts of pointers		to organize the data	L3
CO4	Apply	the concepts of structures, unions and linked list		to manage heterogeneous data	L3
CO5	Create	the file applications		for storing and accessing data	L6

List of Experiments:

Exercise 1: Problem-solving using Computers [CO1]

- Basic Linux environment and its editors like Vi, Vim & Emacs etc.
- Exposure to Turbo C, gcc
- Writing simple programs using printf(), scanf()

Exercise 2: Problem-solving using Algorithms and Flow charts. [CO1]

- Sum and average of 3 numbers
- Conversion of Fahrenheit to Celsius and vice versa
- Simple interest calculation

Exercise 3: Variable types and type conversions [CO2]

- Finding the square root of a given number
- Finding compound interest
- Area of a triangle using heron's formulae
- Distance travelled by an object

Exercise 4: Operators and the precedence and as associativity [CO2]

- Evaluate the following expressions.
 - $A+B*C+(D*E) + F*G$
 - $A/B*C-B+A*D/3$
 - $A+++B---A$
 - $J= (i++) + (++i)$
- Find the maximum of three numbers using conditional operator
- Take marks of 5 subjects in integers, and find the total, average in float list and perform insertion, deletion, and traversal.

Exercise 5: Branching and logical expressions [CO2]

- Write a C program to find the max and min of four numbers using if-else.
- Write a C program to generate electricity bill.
- Find the roots of the quadratic equation.
- Write a C program to simulate a calculator using switch case.
- Write a C program to find the given year is a leap year or not.



Exercise 6: Loops, while and for loops [CO2]

- i) Find the factorial of given number using any loop.
- ii) Find the given number is a prime or not.
- iii) Compute sine and cos series
- iv) Checking a number palindrome
- v) Construct a pyramid of numbers.

Exercise 7: 1 D Arrays: searching [CO3]

- i) Find the min and max of a 1-D integer array.
- ii) Perform linear search on 1D array.
- iii) The reverse of a 1D integer array
- iv) Find 2's complement of the given binary number.
- v) Eliminate duplicate elements in an array.

Exercise 8: 2 D arrays, sorting and Strings [CO3]

- i) Addition of two matrices
- ii) Multiplication two matrices
- iii) Sort array elements using bubble sort
- iv) Concatenate two strings without built-in functions
- v) Reverse a string using built-in and without built-in string functions

Exercise 9: Pointers, structures and dynamic memory allocation [CO3]

- i) Write a C program to find the sum of a 1D array using malloc()
- ii) Write a C program to find the total, average of n students using structures
- iii) Enter n students data using calloc() and display failed students list
- iv) Read student name and marks from the command line and display the student details along with the total.
- v) Write a C program to implement realloc()

Exercise 10: Bitfields, Self-Referential Structures, Linked lists [CO4]

- i) Create and display a singly linked list using self-referential structure.
- ii) Demonstrate the differences between structures and unions using a C program.
- iii) Write a C program to shift/rotate using bitfields.
- iv) Write a C program to copy one structure variable to another structure of the same type.

Exercise 11: Functions, call by value, scope and extent [CO2]

- i) Write a C function to calculate NCR value.
- ii) Write a C function to find the length of a string.
- iii) Write a C function to transpose of a matrix.
- iv) Write a C function to demonstrate numerical integration of differential equations using Euler's method

Exercise 12: Recursion, the structure of recursive calls [CO4]

- i) Write a recursive function to generate Fibonacci series.
- ii) Write a recursive function to find the lcm of two numbers.
- iii) Write a recursive function to find the factorial of a number.
- iv) Write a C Program to implement Ackermann function using recursion.
- v) Write a recursive function to find the sum of series.

Exercise 13: Call by reference, dangling pointers [CO4]

- i) Write a C program to swap two numbers using call by reference.
- ii) Demonstrate Dangling pointer problem using a C program.
- iii) Write a C program to copy one string into another using pointer.
- v) Write a C program to find no of lowercase, uppercase, digits and other characters using pointers.

Exercise 14: File handling [CO5]

- i) Write a C program to write and read text into a file.
- ii) Write a C program to write and read text into a binary file using fread() and fwrite()
- iii) Copy the contents of one file to another file.
- iv) Write a C program to merge two files into the third file using command-line arguments.
- v) Find no. of lines, words and characters in a file
- vi) Write a C program to print last n characters of a given file.

Textbooks:

1. 1. Ajay Mittal, Programming in C: A practical approach, Pearson.
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw Hill

Reference Books:



- | | |
|----|---|
| 1. | 1 Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice- Hall of India |
| 2. | C Programming, A Problem-Solving Approach, Forouzan, Gilberg, Prasad, CENGAGE |

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	2	2								2	
CO2	3	3		3							2	2	
CO3	3	3		2	3						3	2	
CO4	3	3	3	2							2	2	
CO5	3	3	3	3							3	2	

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) : Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
1	CO1: understand	L2	PO1	PO1: Apply(L3)	2
			PO2	PO2: Review(L2)	3
			PO3	PO3: Develop(L3)	2
			PO4	PO4: Analyze(L4)	2
2	CO2: Create	L6	PO1	PO1: Apply(L3)	3
			PO2	PO2: Review (L3)	3
			PO4	PO4: Analyze (L4)	3
			PO5	PO5: Apply(L3)	3
3	CO3: Apply	L3	PO11	PO11: Thumb rule	2
			PO1	PO1: Apply(L3)	3
			PO2	PO2: Review (L3)	3
			PO4	PO4: Analyze (L4)	2
4	CO4: Apply	L3	PO5	PO5: Apply(L3)	3
			PO11	PO11: Thumb rule	3
			PO1	PO1: Apply(L3)	3
			PO2	PO2: Review (L2)	3
5	CO5: Create	L6	PO3	PO3: Develop(L3)	3
			PO4	PO4: Analyze (L4)	2
			PO11	PO11: Thumb rule	2
			PO1	PO1: Apply(L3)	3
5	CO5: Create	L6	PO2	PO2: Review(L2)	3
			PO3	PO3: Develop(L3)	3
			PO4	PO4: Analyze (L4)	3
			PO11	PO11: Thumb rule	3

Justification Statements :

CO1: Understand the basic syntax of C program to build applications.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate (2)

PO2 Verb: Review(L2)

CO1 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO3: Develop(L3)

CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is moderate (2)

PO4: Analyze(L4)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is moderate is (2)

CO2: Create the control structure for solving complex problems.

Action Verb: Create (L6)

PO1: Apply (L3)

CO2 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Review (L3)



C02 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

C02 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

PO5: Apply(L3)

C02 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (2)

C03: Apply the concepts of arrays, functions, basic concepts of pointers to organize the data..

Action Verb: Apply (L3)

PO1: Apply (L3)

C03 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Review (L3)

C03 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

C03 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2)

PO5: Apply(L3)

C03 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (3)

C04: Apply the concepts of structures, unions and linked list to manage heterogeneous data.

Action Verb: Apply (L3)

PO1: Apply (L3)

C04 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Review (L3)

C04 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

C04 Action verb is less than PO4 verb by one level. Therefore, the correlation is moderate (2)

PO5: Apply(L3)

C04 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (2)

C05: Create the file applications for storing and accessing data.

Action Verb: Create (L6)

PO1: Apply (L3)

C05 Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2: Review (L3)

C05 Action verb is same level PO2 verb. Therefore, the correlation is high (3)

PO4: Analyze (L4)

C05 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

PO5: Apply(L3)

C05 Action verb is same as PO5 verb. Therefore, the correlation is high (3)

PO11: Thumb rule

For some of Linear Data Structure applications, Linked lists concepts are used to write programs store the data. Therefore, the correlation is high (3)



Year: I

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AHM9904	NSS/NCC/Scouts & Guides/ Community Service	0	0	1	0.5

Course Outcomes:

CO: 1 Understand the importance of discipline, character and service motto of community.

CO: 2 Analyze the activities need to be done for nature protection

CO: 3 Analyze the social issues in a community and address it through the base camps

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the importance of discipline, character and service motto		of community	L1
CO2	Analyze	the activities need to be done for nature protection			L4
CO3	Analyze	the social issues in a community and address it through the base camps			L4

UNIT-I

Orientation

General Orientation on NSS/NCC/ Scouts & Guides/Community Service activities, career guidance.

Activities:

- Conducting –ice breaking sessions-expectations from the course-knowing personal talents and skills.
- Conducting orientations programs for the students –future plans-activities-releasing road map etc.
- Displaying success stories-motivational biopics- award winning movies on societal issues etc.
- Conducting talent show in singing patriotic songs-paintings- any other contribution.

UNIT-II

Nature & Care

Activities:

- Best out of waste competition.
- Poster and signs making competition to spread environmental awareness.
- Recycling and environmental pollution article writing competition.
- Organizing Zero-waste day.
- Digital Environmental awareness activity via various social media platforms.
- Virtual demonstration of different eco-friendly approaches for sustainable living.
- Write a summary on any book related to environmental issues.



UNIT-III

Community Service

Activities:

- Conducting One Day Special Camp in a village contacting village-area leaders- Survey in the village, identification of problems- helping them to solve via media- authorities- experts-etc.
- Mental health, Spiritual Health, HIV/AIDS,
- Conducting consumer Awareness. Explaining various legal provisions etc.
- Women Empowerment Programmes- Sexual Abuse, Adolescent Health and Population Education.
- Any other programmes in collaboration with local charities, NGOs etc.
- Conducting awareness programs on Health-related issues such as General Health.

CO-POMAPPING JUSTIFICATION:

Unit No	Course Outcomes		Program Outcome (PO)	PO(s):Action Verb and BTL(forPO1 to PO12)	Level of Correlation (0-3)
	CO's Action Verb	BTL			
1	Understand	L2	PO1 PO2 PO10	Apply(L3) Analyze(L4) Thumb Rule	2 3 3
2	Analyze	L4	PO1 PO2 PO10	Apply(L3) Analyze(L4) Thumb Rule	2 3 3
3	Analyze	L4	PO1 PO2 PO10	Apply(L3) Analyze(L4) Thumb Rule	2 3 3

Mapping of COs to POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1	2	2								2			2
2	3	3								3			2
3	3	3								3			2

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

AK23 Regulations

B. Tech – I Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	HM	23AHM9901	Communicative English	2	0	0	2	30	70	100
2	BS	23ABS9902	Engineering Chemistry	2	1	0	3	30	70	100
3	BS	23ABS9905	Differential Equations & Vector Calculus	2	1	0	3	30	70	100
4	ES	23AES0101	Basic Civil & Mechanical Engineering	2	1	0	3	30	70	100
5	PC	23APC0101	Engineering Mechanics	2	1	0	3	30	70	100
6	HM	23AHM9902	Communicative English Lab	0	0	2	1	30	70	100
7	BS	23ABS9907	Engineering Chemistry Lab	0	0	2	1	30	70	100
8	ES	23AES0302	Engineering Workshop	0	0	3	1.5	30	70	100
9	PC	23APC0301	Engineering Mechanics Lab	0	0	3	1.5	30	70	100
10	HM	23AHM9903	Health and wellness, Yoga and Sports	-	-	1	0.5	50	-	50
Total				10	4	11	19.5	320	630	950



Year: I

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AHM9901	Communicative English	2	0	0	2

Course Outcomes:

- CO: 1 Understand reading / listening texts and to write summaries based on global comprehension of these texts. **(Listening & Reading)**
- CO: 2 Apply grammatical structures to formulate sentences and correct word forms. **(Grammar)**
- CO: 3 Analyze discourse markers to speak clearly on a specific topic in formal and informal conversations. **(Speaking)**
- CO: 4 Analyze a coherent paragraph interpreting graphic elements, figure/graph/chart/table **(Read & Write)**
- CO: 5 Create a coherent essay, letter writing, report writing and design a resume. **(Writing)**

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	reading / listening texts and to write summaries based on global comprehension of these texts.			L2
2	Apply	grammatical structures to formulate sentences and correct word forms			L3
3	Analyze	Analyze discourse markers to speak clearly on a specific topic in formal and informal conversations...			L4
4	Analyze	coherent paragraph interpreting a graphic elements.			L4
5	Create	coherent essay, letter writing, report writing and design a resume			L6

UNIT I

Lesson: HUMAN VALUES: Gift of Magi (Short Story)

- Listening:** Identifying the topic, the context and specific pieces of information by listening to short audio texts and answering a series of questions.
- Speaking:** Asking and answering general questions on familiar topics such as home, family, work, studies and interests; introducing oneself and others.
- Reading:** Skimming to get the main idea of a text; scanning to look for specific pieces of information.
- Writing:** Mechanics of Writing-Capitalization, Spellings, Punctuation-Parts of Sentences.
- Grammar:** Parts of Speech, Basic Sentence Structures-forming questions
- Vocabulary:** Synonyms, Antonyms, Affixes (Prefixes/Suffixes), Root words.

UNIT II

Lesson: NATURE: The Brook by Alfred Tennyson (Poem)

- Listening:** Answering a series of questions about main ideas and supporting ideas after listening to audio texts.
- Speaking:** Discussion in pairs/small groups on specific topics followed by short structure talks.
- Reading:** Identifying sequence of ideas; recognizing verbal techniques that help to link the ideas in a paragraph together.



Writing: Structure of a paragraph - Paragraph writing (specific topics) **Grammar:**
Cohesive devices - linkers, use of articles and zero article; prepositions.

Vocabulary: Homonyms, Homophones, Homographs.

UNIT III

Lesson: BIOGRAPHY: Elon Musk

Listening: Listening for global comprehension and summarizing what is listened to.

Speaking: Discussing specific topics in pairs or small groups and reporting what is discussed

Reading: Reading a text in detail by making basic inferences - recognizing and interpreting specific context clues; strategies to use text clues for comprehension.

Writing: Summarizing, Note-making, paraphrasing

Grammar: Verbs - tenses; subject-verb agreement.

Vocabulary: Compound words, Collocations

UNIT IV

Lesson: INSPIRATION: The Toys of Peace by Saki

Listening: Making predictions while listening to conversations/ transactional dialogues without video; listening with video.

Speaking: Role plays for practice of conversational English in academic contexts (formal and informal) - asking for and giving information/directions.

Reading: Studying the use of graphic elements in texts to convey information, reveal trends/patterns/relationships, communicate processes or display complicated data.

Writing: Letter Writing: Official Letters, Resumes, Cover letters

Grammar: Reporting verbs, Direct & Indirect speech, Active & Passive Voice

Vocabulary: Words often confused, Jargons

UNIT V

Lesson: MOTIVATION: The Power of Intrapersonal Communication (An Essay)

Listening: Identifying key terms, understanding concepts and answering a series of relevant questions that test comprehension.

Speaking: Formal oral presentations on topics from academic contexts

Reading: Reading comprehension.

Writing: Writing structured essays on specific topics.

Grammar: Editing short texts –identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement)

Vocabulary: Idiom and phrases & Phrasal verbs

Textbooks:

1. Pathfinder: Communicative English for Undergraduate Students, 1st Edition, Orient Black Swan, 2023 (Units 1,2 & 3)
2. Empowering with Language by Cengage Publications, 2023 (Units 4 & 5)

Reference Books:

1. Dubey, Sham Ji& Co. English for Engineers, Vikas Publishers, 2020
2. Bailey, Stephen. Academic writing: A Handbook for International Students. Routledge, 2014.



3. Murphy, Raymond. English Grammar in Use, Fourth Edition, Cambridge University Press, 2019.
4. Lewis, Norman. Word Power Made Easy- The Complete Handbook for Building a Superior Vocabulary. Anchor, 2014.

Web Resources:

GRAMMAR:

1. www.bbc.co.uk/learningenglish
2. <https://dictionary.cambridge.org/grammar/british-grammar/>
3. www.eslpod.com/index.html
4. <https://www.learngrammar.net/>
5. <https://english4today.com/english-grammar-online-with-quizzes/>
6. <https://www.talkenglish.com/grammar/grammar.aspx>

VOCABULARY

1. <https://www.youtube.com/c/DailyVideoVocabulary/videos>
2. https://www.youtube.com/channel/UC4cmBAit8i_NJZE8qK8sfpA



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

Course structure for Four Year Regular B.Tech. Degree Program

(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

AK23 Regulations

Year: I

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ABS9902	Engineering Chemistry	2	1	0	3

Course Outcomes:

- CO: 1 Understand the purification techniques to remove hardness of water
 CO: 2 Apply the electrochemical principles to the energy storage devices and corrosion prevention techniques
 CO: 3 Analyze the preparation of polymers, elastomers and fuels
 CO: 4 Analyse the properties of lubricants, Refractories, composites and cement.
 CO: 5 Analyze the properties of colloids and nano materials

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	Purification techniques		to remove hardness of water	L2
2	Apply	electrochemical principles to the energy storage devices and corrosion prevention techniques			L3
3	Analyze	preparation of polymers, elastomers and fuels			L4
4	Analyze	properties of lubricants, Refractories, composites and cement			L4
5	Analyze	Properties of colloids and nano materials			L4

UNIT I Water Technology

Soft and hardwater, Estimation of hardness of water by EDTA Method, Estimation of dissolved Oxygen - Boiler troubles – Priming, foaming, scale and sludge, Caustic embrittlement, Industrial water treatment – Specifications for drinking water, Bureau of Indian Standards (BIS) and World health organization (WHO) standards, Ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electrodialysis.

UNIT II Electrochemistry and Applications

Electrodes – electrochemical cell, Nernst equation, cell potential calculations. Primary cells – Zinc-air battery, Secondary cells – Nickel-Cadmium (NiCad), and lithium ion batteries- working principle of the batteries including cell reactions; Fuel cells-Basic Concepts, the principle and working of hydrogen-oxygen Fuel cell.

Corrosion: Introduction to corrosion, electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, metal oxide formation by dry corrosion, Pilling Bedworth ratios and uses, Factors affecting the corrosion, cathodic and anodic protection, electroplating and electroless plating (Nickel and Copper).



UNIT III Polymers and Fuel Chemistry

Introduction to polymers, functionality of monomers, Mechanism of chain growth, step growth polymerization. Thermoplastics and Thermo-setting plastics:- Preparation, properties and applications of polystyrene. PVC Nylon 6,6 and Bakelite.

Elastomers – Preparation, properties and applications of Buna S, Buna N, Thiokol rubbers. **Fuels** – Types of fuels, calorific value of fuels, numerical problems based on calorific value; Analysis of coal (Proximate and Ultimate analysis), Liquid Fuels, refining of petroleum, Octane and Cetane number- alternative fuels- propane, methanol, ethanol and bio fuel-bio diesel.

UNIT IV Modern Engineering Materials

Composites- Definition, Constituents, Classification- Particle, Fibre and Structural reinforced composites, properties and Engineering applications.

Refractories- Classification, Properties, Factors affecting the refractory materials and Applications.

Lubricants- Classification, Functions of lubricants, Mechanism, Properties of lubricating oils –Viscosity, Viscosity Index, Flash point, Fire point, Cloud point, saponification and Applications.

Building materials- Portland Cement, constituents, Setting and Hardening of cement.

UNIT V Surface Chemistry and Nanomaterials

Introduction to surface chemistry, colloids, nanometals and nanometal oxides, micelle formation, synthesis of colloids (Braggs Method), chemical and biological methods of preparation of nanometals and metal oxides, stabilization of colloids and nanomaterials by stabilizing agents, adsorption isotherm (Freundlich and Langmuir), BET equation (no derivation) applications of colloids and nanomaterials – catalysis, medicine, sensors, etc.

Textbooks:

1. Jain and Jain, Engineering Chemistry, 16/e, Dhanpat Rai, 2013.
2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10/e, Oxford University Press, 2010.

Reference Books:

1. H.F.W. Taylor, Cement Chemistry, 2/e, Thomas Telford Publications, 1997.
2. D.J. Shaw, Introduction to Colloids and Surface Chemistry, Butterworth-Heinemann, 1992.

Textbook of Polymer Science, Fred W. Billmeyer Jr, 3rd Edition.

Mapping of COs to POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1	2												
2	3												
3		3											
4		3											
5		3											

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)



CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours				CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	
	Register (Hrs)	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	10	12	18.4	3	Understand	L2	PO1	PO1: Apply (L3)	
2	10	22	33.8	3	Apply	L3	PO1	PO1: Apply (L3)	
3	10	12	18.4	3	Analyze	L4	PO2	PO2: Analyze (L4)	
4	10	6	9.2	1	Analyze	L4	PO1	PO1: Analyze (L4)	
5	10	13	20	3	Analyze	L4	PO2	PO2: Analyze (L4)	3

CO1: Understand the purification techniques to remove hardness of water

Action Verb: Understand (L2)

PO1 Verbs: Apply (L3)

CO1 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate (2).

CO2: Apply the electrochemical principles to the energy storage devices and corrosion prevention techniques

Action Verb: Apply (L3)

PO1 Verbs: Apply (L3)

CO2 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

CO3: Analyze the preparation of polymers and fuels

Action Verb: Analyze (L4)

PO2 Verb: Analyze (L4)

CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO4: Analyse the properties of lubricants, Refractories, composites and cement.

Action Verb: Analyze (L4)

PO2 Verb: Analyze (L4)

CO4 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO5: Analyze the Properties of colloids and nano materials

Action Verb: Analyze (L4)

PO1 Verb: Analyze (L4)

CO5 Action verb is equal to PO2 verb; therefore the correlation is high (3).



Year: I

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ABS9905	Differential Equations and Vector Calculus	2	1	0	3

Course Outcomes:

- CO: 1 Apply the concepts of ordinary differential equations of first order and first degree.
 CO: 2 Apply the methods of linear differential equations related to various engineering problems.
 CO: 3 Analyze the solutions of partial differential equations using Lagrange's method.
 CO: 4 Understand the different operators and identities in the vector calculus.
 CO: 5 Evaluate the surface integral and volume integral in the vector calculus using various theorems

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	The concepts of ordinary differential equations.		of first order and first degree	L3
2	Apply	The methods of linear differential equations related to various engineering problems.			L3
3	Analyze	The solutions of partial differential equations.	Using Lagrange's method		L4
4	Understand	different operators and identities in the vector calculus.			L2
5	Evaluate	the surface integral and volume integral in the vector calculus.	Using various theorems		L5

UNIT I: Linear Differential Equations of first Order and first Degree

9hrs

Linear differential equations-Bernoulli's equations-Exact equations and equations reducible to exact form. Applications: Newton's Law of cooling-Law of natural growth and decay-Electrical circuits.

UNIT II: Equations Reducible to Linear Differential Equations and Applications

9 hrs

Definitions, homogeneous and non-homogeneous, complementary function, general solution, particular integral, Wronskian, Method of variation of parameters. Simultaneous linear equations, Applications to L-C-R Circuit problems and simple Harmonic motion.

UNIT III: Partial Differential Equations

9 hrs

Introduction and formation of partial differential Equations by elimination of arbitrary constants and arbitrary functions, solutions of first order linear equations using Lagrange's method. Homogeneous Linear Partial differential equations with constant coefficients.

UNIT IV: Vector differentiation

9 hrs

Scalar and vector point functions, vector operator del, del applies to scalar point functions-Gradient, Directional derivative, del applied to vector point functions-Divergence and Curl, vector identities.

UNIT V: Vector integration

9 hrs

Line integral-circulation-work done, surface integral-flux, Green's theorem in the plane (without proof), Stoke's theorem (without proof), volume integral, Divergence theorem (without proof) and applications of these theorems.



Text Books :

1. B. S. Grewal, Higher Engineering Mathematics, 44th Edition, Khanna publishers, 2017.
2. Erwin Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley & Sons, 2011.

References:

1. Dr.T.K.V.Iyengar, Engineering Mathematics-I,S.Chand publishers
2. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, 3/e, Alpha Science International Ltd., 2002
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics,Laxmipublication,2008
4. B. V. Ramana, Higher Engineering Mathematics, McGraw Hill Education.

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	3										
2	3										
3		3									
4	2										
5		3									

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	14	20.8	3	Apply	L4	PO1	Apply	3
2	15	22.3	3	Apply	L3	PO1	Apply	3
3	14	20.8	3	Analyze	L4	PO2	Analyze	3
4	9	13.4	2	Understand	L2	PO1	Apply	2
5	15	22.3	3	Evaluate	L5	PO2	Analyze	3

CO1: Apply the concepts of ordinary differential equations of first order and first degree.

Action Verb: Apply(L3)

PO1 Verbs: Apply(L3)

CO1 Action Verb is equal to PO1 verb Therefore correlation is high (3).

CO2: Apply the methods of linear differential equations related to various engineering problems.

Action Verb: Apply (L3)

PO1 Verbs: Apply (L3)

CO2 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

CO3: Analyze the solutions of partial differential equations.

Action Verb: Analyze(L4)

PO2 Verb: Analyze (L4)

CO3 Action Verb level is equal to PO2 verb; Therefore correlation is high (3).

CO4: Understand the different operators and identities in the vector calculus.

Action Verb: Understand(L2)

PO1 Verb: Apply(L3)

CO4 Action Verb is low level to PO1 to one level; Therefore correlation is moderate (2).

CO5: Evaluate the surface integral and volume integral in the vector calculus.

Action Verb: Evaluate(L5)

PO2 Verb: Analyze (L4)

CO5 Action verb is high level to PO2 verb; therefore the correlation is high (3).



Year: I

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0101	Basic Civil & Mechanical Engineering	2	1	0	3

Course Outcomes:

- CO: 1 Understand various sub-divisions of Civil Engineering and to appreciate their role in ensuring better society
- CO: 2 Apply the methods of surveying in finding the measurements on Earth surface
- CO: 3 Understand the importance of transportation, water resources and environmental engineering
- CO: 4 Understand the applications and role of various materials in Mechanical Engineering
- CO: 5 Understand the different manufacturing processes and the basics of thermal engineering with its applications
- CO: 6 Understand the working of different mechanical power transmission systems, power plants and applications of robotics

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	Various sub-divisions of Civil Engineering		role in ensuring better society	L2
2	Apply	Methods of surveying	finding the measurements	on Earth surface	L3
3	Understand	Importance of transportation, water resources and environmental engineering			L2
4	Understand	applications and role of various materials in Mechanical Engineering			L2
5	Understand	different manufacturing processes and the basics of thermal engineering with its applications			L2
6	Understand	working of different mechanical power transmission systems, power plants and applications of robotics			L2

BASICS OF CIVIL ENGINEERING

(PART-A)

UNIT I

Basics of Civil Engineering:

Role of Civil Engineers in Society- Various Disciplines of Civil Engineering- Structural Engineering- Geo-technical Engineering- Transportation Engineering Hydraulics and Water Resources Engineering - Environmental Engineering-Scope of each discipline - Building Construction and Planning- Construction Materials-Cement - Aggregate - Bricks- Cement concrete- Steel. Introduction to Prefabricated construction Techniques.

UNIT II



Surveying: Objectives of Surveying- Horizontal Measurements- Angular Measurements- Introduction to Bearings Levelling instruments used for levelling -Simple problems on levelling and bearings-Contour mapping.

UNIT III

Transportation Engineering: Importance of Transportation in Nation's economic development- Types of Highway Pavements- Flexible Pavements and Rigid Pavements - Simple Differences. Basics of Harbour, Tunnel, Airport, and Railway Engineering.

Water Resources and Environmental Engineering:

Introduction, Sources of water- Quality of water- Specifications- Introduction to Hydrology–Rainwater Harvesting-Water Storage and Conveyance Structures (Simple introduction to Dams and Reservoirs).

Textbooks:

1. Basic Civil Engineering, M.S.Palanisamy, , Tata Mcgraw Hill publications (India) Pvt.Ltd. Fourth Edition.
2. Introduction to Civil Engineering, S.S. Bhavikatti, New Age International Publishers.2022. First Edition.
3. Basic Civil Engineering, Satheesh Gopi, Pearson Publications, 2009, First Edition

Reference Books:

1. Surveying, Vol- I and Vol-II, S.K. Duggal, Tata McGraw Hill Publishers 2019. Fifth Edition
2. Hydrology and Water Resources Engineering, Santosh Kumar Garg, Khanna Publishers, Delhi. 2016
3. Irrigation Engineering and Hydraulic Structures - Santosh Kumar Garg, Khanna Publishers, Delhi 2023. 38th Edition
4. Highway Engineering, S.K.Khanna, C.E.G. Justo and Veeraraghavan, Nemchand and Brothers Publications 2019. 10th Edition
5. Indian Standard DRINKING WATER — SPECIFICATION IS 10500-2012

BASICS OF MECHANICAL ENGINEERING

(PART-B)

UNIT I

Introduction to Mechanical Engineering: Role of Mechanical Engineering in Industries and Society – Technologies in different sectors such as Energy, Manufacturing, Automotive, Aerospace, and Marine sectors.

Engineering Materials – Metals _Ferrous and Non-ferrous, ceramics, Composites, smart materials.

UNIT II

Manufacturing Processes: Principles of casting, forming, joining processes, Machining, Introduction to CNC Machines, 3D printing and smart manufacturing.

Thermal Engineering – Working principles of Boilers, Otto cycle, Diesel cycle, Refrigeration and air-conditioning cycles, IC engines, 2-stroke and 4 –stroke engines SI/CI engines, components of electric and hybrid vehicles.

UNIT-III

Power plants: Working principle of steam, diesel, Hydro, Nuclear power plants.



Mechanical Power transmission – Belt drive, chain, rope drives, gear drives and their applications.

Introduction to Robotics – Joints and links, configurations and applications of robotics.

Textbooks:

1. Internal Combustion Engines by V. Ganesan, by Tata McGra Hill Publications (india) Pvt. Ltd.
2. A text book of theory of machines by SS Ratan Tata McGra Hill Publications (india) Pvt. Ltd.
3. An introduction of Mechanical Engg by Jonathan Wicker and Kember Lewis, Cengage learning India Pvt. Ltd.

Reference Books:

1. Appuu Kuttan KK, Robotics, I K International Publishing House Pvt.Ltd. Volume –I
2. 3D printing and Additive manufacturing technology –L. Jyothish Kumar, Pulak Mpandey, Springer publications.
- 3 Thermal Engineering by Mahesh M Rathore Tata McGra Hill Publications (india) Pvt. Ltd.
4. G. Shanmugan and M.S Palaniswamy, Basic Civil and the Mechanical Engineering, Tata McGra Hill Publications (india) Pvt. Ltd.
5. Elements of Mechanical Engineering – Dr. M. Maruthi Rao, IIP – Bangalore.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO2
BCME	CO1	2	2					2						
	CO2	3	2				2							
	CO3	2	2					2						
	CO4	2					2							
	CO5	2						2						
	CO6	2				2		2						

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	11/33	33	2	Understand	L2	PO1 PO2 PO7	Apply (L3) Analyze (L3) Thumb Rule	2 2 2
2	12/33	34	3	Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2
3	11/33	33	2	Understand	L2	PO1 PO2 PO7	Apply (L3) Analyze (L3) Thumb Rule	2 2 2
4	9/30	30	3	Understand	L2	PO1 PO6	Identify-L3 Thumb Rule	2 2
5	12/30	40	3	Understand	L2	PO1 PO7	Identify-L3 Thumb Rule	2 2



6	9/30	30	3	Understand	L2	PO1 PO5 PO7	Apply(Identify)-L3 Apply-L3 Thumb Rule	2 2 2
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Justification Statements:

CO1: Understand various sub-divisions of Civil Engineering and to appreciate their role in ensuring better society.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is not same level as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Analyze(L4)**

CO1 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)

PO7 Verb: **Thumb Rule**

CO1 correlates medium with PO7. Therefore, the correlation is medium (2)

CO2: Apply the methods of surveying in finding the measurements on Earth surface.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze(L4)**

CO2 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: **Thumb Rule**

CO2 correlates medium with PO6. Therefore, the correlation is medium (2)

CO3: Understand the importance of transportation, water resources and environmental engineering.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO3 Action verb is not same level as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Analyze(L4)**

CO3 Action verb is not same level as PO2 verb. Therefore, the correlation is medium (2)

PO7 Verb: **Thumb Rule**

CO3 correlates medium with PO7. Therefore, the correlation is medium (2)

CO4: Understand the applications and role of various materials in Mechanical Engineering.

Action Verb: **Understand (L2)**

PO1 Verb: **Apply (L3)**

CO4 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: **Review-L2**

CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)



PO7 Verb: **Thumb Rule**

CO4 correlates moderately with PO6. Therefore, the correlation is medium (2).

CO5: Understand the different manufacturing processes and the basics of thermal engineering with its applications.

Action Verb: **Understand (L2)**

PO1 Verb: **Apply (L3)**

CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: **Review-L2**

CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO7 Verb: **Thumb Rule**

CO5 correlates moderately with PO6. Therefore, the correlation is medium (2).

CO6: Understand the working of different mechanical power transmission systems, power plants and applications of robotics.

Action Verb: **Understand (L2)**

PO1 Verb: **Apply (L3)**

CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: **Review-L2**

CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO7 Verb: **Thumb Rule**

CO5 correlates moderately with PO6. Therefore, the correlation is medium (2).



Year: I

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0101	Engineering Mechanics	2	1	0	3

Course Outcomes:

- CO: 1 Apply the concepts of system of forces and frictional forces for contact bodies
CO: 2 Analyze the different force systems to calculate their resultant forces and moments.
CO: 3 Apply the concepts of centroid and moment of inertia for different cross-sections.
CO: 4 Apply the principles of work-energy and impulse-momentum of rectilinear and curvilinear motion of a particle.
CO: 5 Apply the principles of work-energy and impulse-momentum of rigid body

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	Concepts of system of forces and frictional forces	for contact bodies		L3
2	Analyze	To calculate their resultant forces and moments of different force systems			L4
3	Apply	Concepts of centroid and moment of inertia	For different cross-sections		L3
4	Apply	Principles of work-energy and impulse-momentum	Rectilinear and curvilinear motion for a particle		L3
5	Apply	Principles of work-energy and impulse-momentum	Rigid body motion for a particle		L3

UNIT I

Introduction to Engineering Mechanics– Basic Concepts. Scope and Applications

Systems of Forces: Coplanar Concurrent Forces– Components in Space–Resultant–Moment of Force and its Application –Couples and Resultant of Force Systems.

Friction: Introduction, limiting friction and impending motion, Coulomb's laws of dry friction, coefficient of friction, Cone of Static friction.

UNIT II

Equilibrium of Systems of Forces: Free Body Diagrams, Lami's Theorem, Equations of Equilibrium of Coplanar Systems, Graphical method for the equilibrium, Triangle law of forces, converse of the law of polygon of forces condition of equilibrium, Equations of Equilibrium for Spatial System of forces, Numerical examples on spatial system of forces using vector approach, Analysis of plane trusses. Principle of virtual work with simple examples.

UNIT III

Centroid: Centroids of simple figures (from basic principles)–Centroids of Composite Figures.

Centre of Gravity: Centre of gravity of simple body (from basic principles), Centre of gravity of composite bodies, Pappus theorems.

Area Moments of Inertia: Definition– Polar Moment of Inertia, Transfer Theorem, Moments of Inertia of Composite Figures, Products of Inertia, Transfer Formula for Product of Inertia.



Mass Moment of Inertia: Moment of Inertia of Masses, Transfer Formula for Mass Moments of Inertia, Mass Moment of Inertia of composite bodies.

UNIT IV

Rectilinear and Curvilinear motion of a particle: Kinematics and Kinetics –D'Alembert's Principle - Work Energy method and applications to particle motion-Impulse Momentum method.

UNIT V

Rigid body Motion: Kinematics and Kinetics of translation, Rotation about fixed axis and plane motion, Work Energy method and Impulse Momentum method.

Textbooks:

1. Engineering Mechanics, S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., , McGraw Hill Education 2017. 5th Edition.
2. Engineering Mechanics, P.C.Dumir- S.Sengupta and Srinivas V veeravalli , University press. 2020. First Edition.
3. A Textbook of Engineering Mechanics, S.S Bhavikatti. New age international publications 2018. 4th Edition.

Reference Books:

1. Engineering Mechanics, Statics and Dynamics, Rogers and M A. Nelson., McGraw Hill Education. 2017. First Edition.
2. Engineering Mechanics, Statics and Dynamics, I.H. Shames., PHI, 2002. 4th Edition.
3. Engineering Mechanics, Volume-I: Statics, Volume-II: Dynamics, J. L. Meriam and L. G. Kraige., John Wiley, 2008. 6th Edition.
4. Introduction to Statics and Dynamics, Basudev Battachatia, Oxford University Press, 2014. Second Edition
5. Engineering Mechanics: Statics and Dynamics, Hibbeler R.C., Pearson Education, Inc., New Delhi, 2022, 14th Edition

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2				2							
CO2	2	3		3		3							
CO3	3	2				2							
CO4	3	2				2							
CO5	3	2				2							

Unit No	Course Outcomes					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson Plan Hrs	%	Correlation	CO's Action Verb	BTL			
1	15	20	3	Apply	L3	PO1 PO2 PO6	Apply (L3) Analyze (L4) Thumb Rule	3 2 2
2	15	20	3	Analyze	L4	PO1 PO2	Apply (L3) Analyze (L3)	3 3



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

						PO4	Analyze (L4)	3
						PO6	Thumb Rule	3
3	15	20	3	Apply	L3	PO1	Apply (L3)	3
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
4	15	20	3	Apply	L3	PO1	Apply (L3)	3
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2
5	15	20	3	Apply	L3	PO1	Apply (L3)	3
						PO2	Analyze (L4)	2
						PO6	Thumb Rule	2

Justification Statements:

CO1: Apply the concepts of system of forces and frictional forces for contact bodies

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO1 Action verb is equal to the level of PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO1 Action verb is above the level of PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: **Thumb Rule**

CO1 correlates highly with PO6. Therefore, the correlation is high (3)

CO2: Analyze the different force systems to calculate their resultant forces and moments.

Action Verb: **Analyze (L4)**

PO1 Verb: **Apply (L3)**

CO2 Action verb is above the level of PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO2 Action verb is above the level of PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: **Analyze (L4)**

CO2 Action verb is above the level of PO4 verb. Therefore, the correlation is high (3)

PO6 Verb: **Thumb Rule**

CO2 correlates highly with PO6. Therefore, the correlation is high (3)

CO3: Apply the concepts of centroid and moment of inertia for different cross-sections.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO3 Action verb is equal to the level of PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO3 Action verb is above the level of PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: **Thumb Rule**

CO3 correlates highly with PO6. Therefore, the correlation is high (3)



CO4: Apply the principles of work-energy and impulse-momentum of rectilinear and curvilinear motion of a particle.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO4 Action verb is equal to the level of PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO4 Action verb is above the level of PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: **Thumb Rule**

CO4 correlates highly with PO6. Therefore, the correlation is high (3)

CO5: Apply the principles of work-energy and impulse-momentum of rigid body motion of a particle.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO5 Action verb is equal to the level of PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO5 Action verb is above the level of PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: **Thumb Rule**

CO5 correlates highly with PO6. Therefore, the correlation is high (3)



Year: I

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AHM9902	Communicative English Lab	0	0	2	1

Course Outcomes:

- CO: 1 Understand-the different aspects of the English language proficiency with emphasis on LSRW skills.
- CO: 2 Apply communication skills through various language learning activities.
- CO: 3 Analyze the English speech sounds, for better listening and speaking.
- CO: 4 Evaluate and exhibit professionalism in participating in debates and group discussions.
- CO: 5 Analyze themselves to face interviews in future

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the different aspects of the English language proficiency with emphasis on LSRW skills			L2
2	Apply	communication skills through various language learning activities			L3
3	Analyze	the English speech sounds, for better listening and speaking.			L4
4	Evaluate	and exhibit professionalism in participating in debates and group discussions			L5
5	Analyze	themselves to face interviews in future			L4

List of Topics:

1. Vowels&Consonants (CO3)
2. Non Verbal Communication (CO2)
3. CommunicationSkills(CO2)
4. RolePlayor ConversationalPractice (CO1,CO2)
5. E-mailWriting (CO1)
6. Just A Minute (CO1,CO2)
7. GroupDiscussions-methods&practice (CO4)
8. Debates-Methods&Practice (CO4)
9. PPTPresentations/PosterPresentation (CO2)
10. InterviewsSkills (CO5)

Suggested Software:

- WaldenInfotech
- YoungIndiaFilms

Reference Books:

1. RamanMeenakshi,Sangeeta-Sharma.*Technical Communication*.OxfordPress.2018.
2. TaylorGrant:*EnglishConversationPractice*,TataMcGraw-HillEducationIndia,2016
3. Hewing's,Martin.*CambridgeAcademicEnglish(B2)*.CUP,2012.
4. J.Sethi&P.V.Dhamija.*ACourse inPhoneticsandSpoken English*, (2nd Ed),Kindle,2013.



WebResources:

SpokenEnglish:

1. www.esl-lab.com
2. www.englishmedialab.com
3. www.englishinteractive.net
4. <https://www.britishcouncil.in/english/online>
5. <http://www.letstalkpodcast.com/>
6. https://www.youtube.com/c/mmmEnglish_Emma/featured
7. <https://www.youtube.com/c/ArnelsEverydayEnglish/featured>
8. <https://www.youtube.com/c/engvidAdam/featured>
9. <https://www.youtube.com/c/EnglishClass101/featured>
10. <https://www.youtube.com/c/SpeakEnglishWithTiffani/playlists>
11. https://www.youtube.com/channel/UCV1h_cBE0Drdx19qkTM0WNw

Voice&Accent:

1. <https://www.youtube.com/user/letstalkaccent/videos>
2. <https://www.youtube.com/c/EngLanguageClub/featured>
3. https://www.youtube.com/channel/UC_OskgZBoS4dAnVUgJVexc
4. https://www.youtube.com/channel/UCNfm92h83W2i2ijc5Xwp_IA

Mapping of COs to POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1										2	
2									2	2	
3										3	
4									3	3	
5										3	

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1				Understand	L2	10	Thumb Rule	2
2				Apply	L3	9,10	Thumb Rule	2,2
3				Analyze	L4	10	Thumb Rule	3
4				Evaluate	L5	9,10	Thumb Rule	3,3
5				Analyze	L4	10	Thumb Rule	3

CO1: Understand the different aspects of the English language proficiency with emphasis on LSRW skills
Action Verb: Understand (L2)

CO1 Action Verb is understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).

CO2: Apply communication skills through various language learning activities.

Action Verb: Apply (L3)

CO2 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate(2).



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
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Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

AK23 Regulations

c03: Analyze the English speech sounds, for better listening and speaking.

Action Verb: Analyze (L4)

CO3 Action Verb is Analyze of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).

c04: Evaluate and exhibit professionalism in participating in debates and group discussions.

Action Verb: Evaluate (L5)

CO4 Action Verb is Evaluate of BTL 5. Using Thumb rule, L5 correlates PO6 to PO11 as high (3).

CO5: Analyze themselves to face interviews in future.

Action Verb: Develop (L4)

CO5 Action Verb is Analyze of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).



Year: I

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ABS9907	Engineering Chemistry Lab	0	0	2	1

Course Outcomes:

- CO: 1 Estimate the hardness of water.
CO: 2 Prepare advanced polymer materials.
CO: 3 Measure the strength of an acid present in secondary batteries.
CO: 4 Estimate the Iron and Calcium in cement.
CO: 5 Determine the physical properties like surface tension, adsorption and viscosity

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Estimate	Hardness of water			L5
2	Prepare	Advanced polymer Bakelite materials			L4
3	Measure	Strength of an acid present in secondary batteries.			L4
4	Estimate	Iron and Calcium in cement			L5
5	Determine	Physical properties like surface tension, adsorption and viscosity			L4

List of Experiments:

1. Determination of Hardness of a groundwater sample (CO1)
2. Estimation of Dissolved Oxygen by Winkler's method (CO3)
3. Determination of Strength of an acid in Pb-Acid battery (CO3)
4. Preparation of a polymer (Bakelite) (CO2)
5. Determination of percentage of Iron in Cement sample by colorimetry (CO4)
6. Estimation of Calcium in port land Cement (CO4)
7. Preparation of nanomaterials by precipitation method (CO5)
8. Adsorption of acetic acid by charcoal (CO4)
9. Determination of percentage Moisture content in a coal sample (CO4)
10. Determination of Viscosity of lubricating oil by Redwood Viscometer 1(CO5)
11. Determination of Viscosity of lubricating oil by Redwood Viscometer 2 (CO5)
12. Estimation of copper by Iodometry (CO3)

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO Experiments may be conducted in virtual mode.

Reference:

Vogel's Quantitative Chemical Analysis 6th Edition 6th Edition

Mapping of COs to POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1				3									
2				3									
3				3									
4				3									
5				3									

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)



CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				Estimate	L5	PO4	PO4: Analyze (L5)	3
2				Prepare	L4	PO4	PO4: Analyze (L4)	3
3				Measure	L4	PO4	PO4: Analyze (L4)	3
4				Estimate	L5	PO4	PO4: Analyze (L5)	3
5				Determine	L4	PO4	PO4: Analyze (L4)	3

CO1: Estimate the hardness of water.

Action Verb: Estimate (L5)

PO4 Verb: Analyze (L4)

CO1 Action Verb is greater than PO4; Therefore correlation is high (3)

CO2: Prepare advanced polymer Bakelite materials.

Action Verb: Prepare (L4)

PO4 Verb: Analyze (L4)

CO2 Action Verb is equal to PO4 verb; Therefore, correlation is high (3)

CO3: Measure the strength of an acid present in secondary batteries.

Action Verb: Measure (L4)

PO4 Verb: Analyze (L4)

CO3 Action Verb is equal to PO4 verb; Therefore, correlation is high (3)

CO4: Estimate the Iron and Calcium in cement.

Action Verb: Estimate (L5)

PO4 Verb: Analyze (L4)

CO4 Action Verb is greater than PO4; Therefore correlation is high (3)

CO5: Determine the physical properties like surface tension, adsorption and viscosity.

Action Verb: Determine (L4)

PO4 Verb: Analyze (L4)

CO5 Action Verb is equal to PO4 verb; Therefore, correlation is high (3)



Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0302	Engineering Workshop	0	0	3	1.5

Course Outcomes:

- CO: 1 Apply the wood working skills to prepare different joints.
 CO: 2 Analyze the sheet metal and fitting operations to prepare various components
 CO: 3 Apply the basic electrical engineering knowledge for house wiring practice.
 CO: 4 Apply the Welding process for Lap and Butt Joints.
 CO: 5 Understand the various plumbing pipe joints

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the wood working skills to prepare different joints			L3
CO2	Analyze	the sheet metal and fitting operations to prepare various components			L4
CO3	Apply	the basic electrical engineering knowledge for house wiring practice			L3
CO4	Apply	the Welding process for Lap and Butt joints			L3
CO5	Understand	the various plumbing pipe joints			L2

SYLLABUS

- Demonstration:** Safety practices and precautions to be observed in workshop.
- Wood Working:** Familiarity with different types of woods and tools used in wood working and make following joints.
 - Half – Lap joint
 - Mortise and Tenon joint
 - Corner Dovetail joint or Bridlejoint
- Sheet Metal Working:** Familiarity with different types of tools used in sheet metal working, Developments of following sheet metal job from GI sheets.
 - Tapered tray
 - Conical funnel
 - Elbow pipe
 - Brazing
- Fitting:** Familiarity with different types of tools used in fitting and do the following fitting exercises.
 - V-fit
 - Dovetail fit
 - Semi-circular fit
 - Bicycle tire puncture and change of two-wheeler tyre
- Electrical Wiring:** Familiarity with different types of basic electrical circuits and make the following connections.
 - Parallel and series
 - Two-way switch
 - Godown lighting
 - Tube light
 - Three phase motor
 - Soldering of wires
- Foundry Trade:** Demonstration and practice on Moulding tools and processes, Preparation of Green Sand Moulds for given Patterns.
- Welding Shop:** Demonstration and practice on Arc Welding and Gas welding. Preparation of Lap joint and Butt joint.
- Plumbing:** Demonstration and practice of Plumbing tools, Preparation of Pipe joints with coupling for same diameter and with reducer for different diameters.

Textbooks:

- Basic Workshop Technology: Manufacturing Process, Felix W.; Independently



Published, 2019. Workshop Processes, Practices and Materials; Bruce J. Black, Routledge publishers, 5th Edn. 2015.

2. A Course in Workshop Technology Vol I. & II, B.S. Raghuwanshi, Dhanpath Rai & Co., 2015 & 2017.

Reference Books:

1. Elements of Workshop Technology, Vol. I by S. K. Hajra Choudhury & Others, Media Promoters and Publishers, Mumbai. 2007, 14th edition
2. Workshop Practice by H. S. Bawa, Tata-McGraw Hill, 2004.

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	3	3						3			3	3
CO2	3	3	3						3			3	3
CO3	3	3	3						3			3	3
CO4	3	3	3						3			3	3
CO5	2	2	2						2			3	3

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	-	-	3	Apply	L3	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	3 3 3 3
2	-	-	3	Analyze	L4	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	3 3 3 3
3	-	-	1	Apply	L3	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	3 3 3 3
4	-	-	2	Apply	L3	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	3 3 3 3
5	-	-	2	Understand	L2	PO1 PO2 PO3 PO9	Apply-L3 Review-L2 Develop-L3 Thumb Rule-L3	2 2 2 2

Justification Statements:

CO1: Apply the wood working skills to prepare different joints

Action Verb: **Apply** (L3)

PO1 Verb: **Apply** (L3)

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review** (L2)

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop** (L3)

CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb Rule**



CO1 Action verb is same level as PO9 verb. Therefore, the correlation is high (3)

CO2: Analyze the sheet metal and fitting operations to prepare various components

Action Verb: **Analyse** (L4)

PO1 Verb: **Apply** (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review** (L2)

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop** (L3)

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb Rule**

CO2 Action verb is same level (greater) as PO9 verb. Therefore, the correlation is high (3)

CO3: Apply the basic electrical engineering knowledge for house wiring practice

Action Verb: **Apply** (L3)

PO1 Verb: **Apply** (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review** (L2)

CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop** (L3)

CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb Rule**

CO3 Action verb is same level as PO9 verb. Therefore, the correlation is high (3)

CO4: Apply the Welding process for Lap and Butt Joints

Action Verb: **Apply** (L3)

PO1 Verb: **Apply** (L3)

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review** (L2)

CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop** (L3)

CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb Rule**

CO4 Action verb is same level as PO9 verb. Therefore, the correlation is high (3)

CO5: Understand the various plumbing pipe joints.

Action Verb: **Understand** (L2)

PO1 Verb: **Apply** (L2)

CO5 Action verb is less than as PO1 verb. Therefore, the correlation is high (2)

PO2 Verb: **Review** (L2)

CO5 Action verb is less than as PO2 verb. Therefore, the correlation is high (2)

PO3 Verb: **Develop** (L3)

CO5 Action verb is less than as PO3 verb. Therefore, the correlation is high (2)

PO9 Verb: **Thumb Rule**

CO5 Action verb is less than as PO9 verb. Therefore, the correlation is high (2)



Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0301	Engineering Mechanics Lab	0	0	3	1.5

Course Outcomes:

- CO: 1 Evaluate the coefficient of friction between two different surfaces and between the inclined plane and the roller.
- CO: 2 Verify Law of Polygon of forces and Law of Moment using force polygon and bell crank lever.
- CO: 3 Determine the Centre of gravity and Moment of Inertia of different configurations
- CO: 4 Verify the equilibrium conditions of a rigid body under the action of different force systems.
- CO: 5 Determine acceleration due to gravity using a compound pendulum.

Students have to perform any 10 of the following Experiments:

1. Verification of Law of Parallelogram of Forces.
2. Verification of Law of Triangle of Forces.
3. Verification of the Law of polygon for coplanar-concurrent forces acting on a particle in equilibrium and to find the value of unknown forces considering particle to be in equilibrium using universal force table.
4. Determination of coefficient of Static and Rolling Frictions
5. Determination of Centre of Gravity of different shaped Plane Lamina.
6. Verification of the conditions of equilibrium of a rigid body under the action of coplanar non-concurrent, parallel force system with the help of a simply supported beam.
7. Study of the systems of pulleys and draw the free body diagram of the system.
8. Determine the acceleration due to gravity using a compound pendulum.
9. Determine the Moment of Inertia of the compound pendulum about an axis perpendicular to the plane of oscillation and passing through its centre of mass.
10. Determine the Moment of Inertia of a Flywheel.
11. Verification of Law of Moment using Rotation Disc Apparatus and Bell Crank Lever.

References:

1. S. Timoshenko, D. H. Young, J.V. Rao, S. Pati., Engineering Mechanics, 5th Edition, McGraw Hill Education.
2. Hibbeler R.C., Engineering Mechanics: Statics and Dynamics, 14th Edition, Pearson Education, Inc., New Delhi, 2022

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3		2										
CO2	3	2											
CO3	3			1									
CO4	3												
CO5	3				3								



Year: I

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AHM9903	Health and Wellness, Yoga and Sports	-	-	1	0.5

Course Outcomes:

- CO: 1 Understand the health & fitness by diet
- CO: 2 Understand the importance of yoga.
- CO: 3 Apply The yoga practices including Surya Namaskar
- CO: 4 Understand the importance of sports.
- CO: 5 Analyze various activities that help enhance their health & Positive Personality

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	Health & fitness by diet			L2
2	Understand	Importance of yoga.			L2
3	Apply	yoga practices including Surya Namaskar			L3
4	Understand	Importance of sports			L2
5	Analyze	Various activities that help enhance their health & Positive Personality			L4

UNIT I

Concept of health and fitness, Nutrition and Balanced diet, basic concept of immunity Relationship between diet and fitness, Globalization and its impact on health, Body Mass Index (BMI) of all age groups.

Activities:

- i) Organizing health awareness programmes in community
- ii) Preparation of health profile
- iii) Preparation of chart for balance diet for all age groups

UNIT II

Concept of yoga, need for and importance of yoga, origin and history of yoga in Indian context, classification of yoga, Physiological effects of Asanas- Pranayama and meditation, stress management and yoga, Mental health and yoga practice.

Activities:

Yoga practices – Asana, Kriya, Mudra, Bandha, Dhyana, Surya Namaskar

UNIT III

Concept of Sports and fitness, importance, fitness components, history of sports, Ancient and Modern Olympics, Asian games and Commonwealth games.

Activities:

- i) Participation in one major game and one individual sport viz., Athletics, Volleyball, Basketball, Handball, Football, Badminton, Kabaddi, Kho-kho, Table tennis, Cricket etc.



Practicing general and specific warm up, aerobics

ii) Practicing cardiorespiratory fitness, treadmill, run test, 9 min walk, skipping and running.

Reference Books:

1. Gordon Edlin, Eric Golanty. Health and Wellness, 14th Edn. Jones & Bartlett Learning, 2022
2. T.K.V.Desikachar. The Heart of Yoga: Developing a Personal Practice
3. Archie J.Bahm. Yoga Sutras of Patanjali, Jain Publishing Company, 1993
4. Wiseman, John Lofty, SAS Survival Handbook: The Ultimate Guide to Surviving Anywhere Third Edition, William Morrow Paperbacks, 2014
5. The Sports Rules Book/ Human Kinetics with Thomas Hanlon. -- 3rd ed. Human Kinetics, Inc. 2014

General Guidelines:

1. Institutes must assign slots in the Timetable for the activities of Health/Sports/Yoga.
2. Institutes must provide field/facility and offer the minimum of five choices of as many Games/Sports.
3. Institutes are required to provide sports instructor / yoga teacher to mentor the students.

Evaluation Guidelines:

- Evaluated for a total of 100 marks.
- A student can select 6 activities of his/her choice with a minimum of 01 activity per unit. Each activity shall be evaluated by the concerned teacher for 15 marks, totaling to 90 marks.
- A student shall be evaluated by the concerned teacher for 10 marks by conducting viva in the subject
- Mapping of COs to POs and PSOs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1						2	2						
2						2	2						
3						2	2						
4						2	2						
5						3	3						

- (Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1					Understand	L2	P06,P07	2
2					Understand	L2	P06,P07	2
3					Apply	L3	P06,P07	2
4					Understand	L2	P06,P07	2
5					Analyze	L4	P06,P07	3

CO1: Understand the health & fitness by diet

Action Verb: Understand (L2)

CO1 Action Verb is **Understand** of BTL 2. Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO2: Understand the Importance of yoga

Action Verb: Understand (L2)

CO2 Action Verb is **Understand** of BTL 2. Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)



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Course structure for Four Year Regular B.Tech. Degree Program
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MECHANICAL ENGINEERING (ME)

AK23 Regulations

CO3: APPLY

yoga practices including Surya Namaskar

Action Verb: APPLY (L3)

CO3 Action Verb is APPLY of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

CO4: Understand Importance of sports

Action Verb: Understand (L2)

CO4 Action Verb is **Understand** of BTL 2.Using Thumb rule; L2 correlates PO6 and PO7 as a moderate (2)

Action Verb: APPLY (L3)

CO5: Analyze the Various activities that help enhance their health & Positive Personality

Action Verb: Analyze (L4)

CO5 Action Verb is Analyze of BTL 2.Using Thumb rule; L4 correlates PO6 and PO7 as a moderate (2)



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AK23 Regulations

B. Tech – II Year I Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	BS	23ABS9911	Numerical Methods & Transform Techniques	2	1	0	3	30	70	100
2	HM	23AHM9905	Universal Human Values	2	1	0	3	30	70	100
3	ES	23AES0303	Thermodynamics	2	0	0	2	30	70	100
4	PC	23APC0302	Mechanics of Solids	2	1	0	3	30	70	100
5	PC	23APC0303	Material Science and Metallurgy	2	1	0	3	30	70	100
6	PC	23APC0304	Mechanics of Solids and Materials Science Lab	0	0	2	1	30	70	100
7	PC	23APC0305	Computer-Aided Machine Drawing	0	0	3	1.5	30	70	100
8	ES	23AES0402	Embedded Systems and IoT	0	0	3	1.5	30	70	100
9	SC	23ASC0501	Python programming	0	1	2	2	30	70	100
Total				10	5	10	20	270	630	900



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ABS9911	Numerical Methods and Transform Techniques	2	1	0	3

Course Outcomes:

- CO: 1 Analyze relevant numerical techniques for interpolation and concepts of curve fitting
- CO: 2 Apply the different iteration methods to solve Algebraic, Transcendental and Simultaneous Equations.
- CO: 3 Evaluate different numerical methods with accuracy and efficiency for ordinary differential equations
- CO: 4 Apply the Laplace transform techniques for solving differential equations (continuous systems).
- CO: 5 Apply Fourier series and Fourier transform in Communication theory and signal analysis.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Analyze	relevant numerical techniques	for interpolation and concepts of curve fitting		L4
2	Apply	the different iteration methods	To solve Algebraic, Transcendental and Simultaneous Equations.		L3
3	Evaluate	different numerical methods with accuracy and efficiency	for ordinary differential equations		L5
4	Apply	Laplace Transform techniques for continuous functions	To solve differential equations.		L3
5	Apply	Fourier series and Fourier transform	in Communication theory and signal analysis		L3

UNIT – I: Interpolation

9hrs

Finite **forward and backward** differences-Newton's forward and **Newton's** backward interpolation formulae – Lagrange's **formula**.

Curve fitting: **By the method of least squares** Fitting of straight line, second-degree **polynomial** and Exponential curve.

UNIT – II: Solution of Algebraic & Transcendental Equations

9hrs

Introduction-Bisection Method-Iterative method, Regula-falsi method and Newton Raphson method.

System of Algebraic equations: **LU decomposition**, Gauss Elimination, **Jacobi methods** and Gauss **Seidal iterative** method.

UNIT – III: Solution of Initial value problems to Ordinary differential equations

9hrs

Numerical **solutions** of Ordinary Differential equations: Taylor's series-Picard's Method of successive Approximations-Euler's and modified Euler's methods-Runge-Kutta methods (second and fourth order).

UNIT-IV: Laplace Transforms

10hrs

Definition-Laplace transform of standard functions-existence of Laplace Transform – Inverse transform – First shifting Theorem, transforms of derivatives and integrals – Unit step function – Second shifting theorem– Convolution theorem – Laplace transform of Periodic function. **Solving linear ordinary differential equations with constant coefficients using Laplace transforms.**



UNIT-V: Fourier series and Fourier transforms

10hrs

Fourier series: **Periodic function**, Determination of Fourier coefficients (Euler's) – Dirichlet conditions for the existence of Fourier series – Fourier series of Even and odd functions – Fourier series in an arbitrary interval – Half-range Fourier sine and cosine expansions.

Fourier transforms: Fourier integral theorem (without proof) – Fourier sine and cosine integrals-complex form of Fourier integral. Fourier transform – Fourier sine and cosine transforms – Properties – Inverse transforms – convolution theorem.

TEXT BOOKS:

1. S S Sastry, Introductory Methods of Numerical Analysis, PHI Learning Private Limited.
2. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 2017, 44th Edition.
3. R.K.Jain and S.R.K.Iyengar, **Advanced Engineering Mathematics**, Alpha Science International Ltd., 2021 5th Edition (9th reprint).

REFERENCES:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons, 2018, 10th Edition.
2. H.K Das, Er.Rajnish Verma, Higher Engineering Mathematics, S.Chand Publications, 2014, Third Edition (Reprint 2021)
3. Alan Jeffrey, Advanced Engineering Mathematics, Elsevier
4. T.K.V.Iyengar, B.Krishna Gandhi, S.Ranganatham, M.V.V.S.N.Prasad, Numerical Methods, S.Chand Publications

Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc17_ma14/preview
2. https://onlinecourses.nptel.ac.in/noc24_ma05/preview
3. <http://nptel.ac.in/courses/111105090>

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1		3									
2	3										
3		3									
4	3										
5	3										

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Action Verb	BTL			
1				Analyze	L4	PO2	Analyze(L4)	3
2				Apply	L3	PO1	Apply(L3)	3
3				Evaluate	L5	PO2	Analyze(L4)	3
4				Apply	L3	PO1	Apply(L3)	3
5				Apply	L3	PO1	Apply(L3)	3

CO1: Analyze relevant numerical techniques for interpolation and concepts of curve fitting.

Action Verb: Analyze (L4)

PO2 Verbs: **Analyze (L4)**

CO1 Action Verb is equal to PO2 verb; Therefore correlation is high (3).

CO2: Apply the different iteration methods to solve Algebraic, Transcendental and Simultaneous Equations.

Action Verb: Apply (L3)

PO1 Verbs: **Apply (L3)**

CO2 Action Verb is equal to PO1 verb; Therefore correlation is high(3).

CO3: Evaluate different methods in numerical analysis with accuracy and efficiency of solutions.

Action Verb: Evaluate (L5)

PO2 Verb: **Analyze (L4)**

CO3 Action Verb is high level to PO2 verb; Therefore correlation is high (3).



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CO4: Apply the Laplace transform techniques for solving differential equations (continuous systems).

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO4 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).

CO5: Apply Fourier series and Fourier transform in Communication theory and signal analysis.

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO5 Action verb is equal to PO2 verb; therefore the correlation is high (3).



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AHM9905	Universal Human Values	2	1	0	3

Course Outcomes:

- CO: 1 Understand the essentials of human values, self-exploration, happiness and prosperity for value added education.
- CO: 2 Analyze the harmony in the human being as sentient 'I' and the material 'Body' in various aspects.
- CO: 3 Apply the nine universal human values in relationships for harmony in the family and orderliness in the society.
- CO: 4 Evaluate the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence.
- CO: 5 Apply the holistic understanding of harmony on professional ethics through augmenting universal human order

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the essentials of human values, self-exploration, happiness and prosperity for value added education.			L2
2	Analyze	the harmony in the human being as sentient 'I' and the material 'Body' in various aspects.			L4
3	Apply	the nine universal human values in relationships for harmony in the family and orderliness in the society.			L3
4	Evaluate	the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence.			L5
5	Apply	the holistic understanding of harmony on professional ethics through augmenting universal human order.			L3

UNIT I Introduction to Value Education (6 lectures and 3 tutorials for practice session)

Lecture 1: Right Understanding, Relationship and Physical Facility (Holistic Development and the Role of Education)

Lecture 2: Understanding Value Education

Tutorial 1: Practice Session PS1 Sharing about Oneself

Lecture 3: self-exploration as the Process for Value Education

Lecture 4: Continuous Happiness and Prosperity – the Basic Human Aspirations

Tutorial 2: Practice Session PS2 Exploring Human Consciousness

Lecture 5: Happiness and Prosperity – Current Scenario

Lecture 6: Method to Fulfill the Basic Human Aspirations

Tutorial 3: Practice Session PS3 Exploring Natural Acceptance

UNIT II Harmony in the Human Being (6 lectures and 3 tutorials for practice session)

Lecture 7: Understanding Human being as the Co-existence of the self and the body.

Lecture 8: Distinguishing between the Needs of the self and the body

Tutorial 4: Practice Session PS4 Exploring the difference of Needs of self and body.

Lecture 9: The body as an Instrument of the self

Lecture 10: Understanding Harmony in the self

Tutorial 5: Practice Session PS5 Exploring Sources of Imagination in the self



Lecture 11: Harmony of the self with the body

Lecture 12: Programme to ensure self-regulation and Health

Tutorial 6: Practice Session PS6 Exploring Harmony of self with the body

UNIT III Harmony in the Family and Society (6 lectures and 3 tutorials for practice session)

Lecture 13: Harmony in the Family – the Basic Unit of Human Interaction

Lecture 14: 'Trust' – the Foundational Value in Relationship

Tutorial 7: Practice Session PS7 Exploring the Feeling of Trust

Lecture 15: 'Respect' – as the Right Evaluation

Tutorial 8: Practice Session PS8 Exploring the Feeling of Respect

Lecture 16: Other Feelings, Justice in Human-to-Human Relationship

Lecture 17: Understanding Harmony in the Society

Lecture 18: Vision for the Universal Human Order

Tutorial 9: Practice Session PS9 Exploring Systems to fulfil Human Goal

UNIT IV Harmony in the Nature/Existence (4 lectures and 2 tutorials for practice session)

Lecture 19: Understanding Harmony in the Nature

Lecture 20: Interconnectedness, self-regulation and Mutual Fulfilment among the Four Orders of Nature

Tutorial 10: Practice Session PS10 Exploring the Four Orders of Nature

Lecture 21: Realizing Existence as Co-existence at All Levels

Lecture 22: The Holistic Perception of Harmony in Existence

Tutorial 11: Practice Session PS11 Exploring Co-existence in Existence.

UNIT V Implications of the Holistic Understanding – a Look at Professional Ethics (6 lectures and 3 tutorials for practice session)

Lecture 23: Natural Acceptance of Human Values

Lecture 24: Definitiveness of (Ethical) Human Conduct

Tutorial 12: Practice Session PS12 Exploring Ethical Human Conduct

Lecture 25: A Basis for Humanistic Education, Humanistic Constitution and Universal Human Order

Lecture 26: Competence in Professional Ethics

Tutorial 13: Practice Session PS13 Exploring Humanistic Models in Education

Lecture 27: Holistic Technologies, Production Systems and Management Models-Typical Case Studies

Lecture 28: Strategies for Transition towards Value-based Life and Profession

Tutorial 14: Practice Session PS14 Exploring Steps of Transition towards Universal Human Order

Textbook and Teachers Manual

a. The Textbook

R R Gaur, R Asthana, G P Bagaria, *A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1

b. The Teacher's Manual

R R Gaur, R Asthana, G P Bagaria, *Teachers' Manual for A Foundation Course in Human Values and Professional Ethics*, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2



Reference Books:

1. *Jeevan Vidya: Ek Parichaya*, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2. *Human Values*, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. *The Story of Stuff* (Book).
4. *The Story of My Experiments with Truth* - by Mohandas Karamchand Gandhi
5. *Small is Beautiful* - E. F Schumacher.
6. *Slow is Beautiful* - Cecile Andrews
7. *Economy of Permanence* - J C Kumarappa
8. *Bharat Mein Angreji Raj* – Pandit Sunderlal
9. *Rediscovering India* - by Dharampal
10. *Hind Swaraj or Indian Home Rule* - by Mohandas K. Gandhi
11. *India Wins Freedom* - Maulana Abdul Kalam Azad
12. *Vivekananda* - Romain Rolland (English)
13. *Gandhi* - Romain Rolland (English)

Online Resources:

1. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%201-Introduction%20to%20Value%20Education.pdf>
2. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%202-Harmony%20in%20the%20Human%20Being.pdf>
3. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%203-Harmony%20in%20the%20Family.pdf>
4. <https://fdp-si.aicte-india.org/UHV%201%20Teaching%20Material/D3-S2%20Respect%20July%2023.pdf>
5. <https://fdp-si.aicte-india.org/UHV-II%20Class%20Notes%20&%20Handouts/UHV%20Handout%205-Harmony%20in%20the%20Nature%20and%20Existence.pdf>
6. <https://fdp-si.aicte-india.org/download/FDPTeachingMaterial/3-days%20FDP-SI%20UHV%20Teaching%20Material/Day%203%20Handouts/UHV%203D%20D3-S2A%20Und%20Nature-Existence.pdf>
7. <https://fdp-si.aicte-india.org/UHV%20II%20Teaching%20Material/UHV%20II%20Lecture%2023-25%20Ethics%20v1.pdf>
8. <https://www.studocu.com/in/document/kiet-group-of-institutions/universal-human-values/chapter-5-holistic-understanding-of-harmony-on-professional-ethics/62490385>
9. https://onlinecourses.swayam2.ac.in/aic22_ge23/preview

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
UNIVERSAL HUMAN	CO1								2			2		
	CO2							3	3					
	CO3						2	2	2					
	CO4						3	3	3			3		
	CO5						2	2	2			2		



CO-PO mapping justification:

Correlation matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1			2	Understand	2	PO8,PO11	Thumb Rule	2,2
2			3	Analyze	4	PO7,PO8	Thumb Rule	3,3
3			2	Apply	3	PO6,PO7,PO8	Thumb Rule	2,2,2
4			3	Evaluate	5	PO6,PO7,PO8,PO11	Thumb Rule	3,3,3,3
5			2	Apply	3	PO6,PO7,PO8,PO11	Thumb Rule	2,2,2,2

Justification Statements:

CO1: Understand the essentials of human values, self-exploration, happiness and prosperity for value added education.

Action Verb: Understand (L2)

CO1 Action Verb is Understand of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).

CO2: Analyze the harmony in the human being as sentient 'I' and the material 'Body' in various aspects.

Action Verb: Analyze (L4)

CO2 Action Verb is Analyze of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3).

CO3: Apply the nine universal human values in relationships for harmony in the family and orderliness in the society.

Action Verb: Apply (L3)

CO3 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2)

CO4: Evaluate the interconnectedness of four orders of nature and holistic perception of harmony at all levels of existence.

Action Verb: Evaluate (L5)

CO4 Action Verb is Evaluate of BTL5. Using Thumb rule, L5 correlates PO6 to PO11 as high (3).

CO5: Apply the holistic understanding of harmony on professional ethics through augmenting universal human order.

Action Verb: Apply (L3)

CO5 Action Verb is Apply of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2).



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0303	Thermodynamics	2	0	0	2

Course Outcomes:

- CO: 1 Understand the concept of thermodynamics system and properties.
CO: 2 Analyze the thermodynamics laws.
CO: 3 Analyze the concept of entropy, Maxwell relations, Helmholtz Functions.
CO: 4 Understand the concept of steam formations and its process.
CO: 5 Evaluate the difference between refrigeration and air conditioning.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concept of thermodynamics system and properties			L2
CO2	Analyze	the thermodynamics laws			L4
CO3	Analyze	the concept of entropy, Maxwell relations, Helmholtz Functions.			L2
CO4	Understand	the concept of steam formations and its process			L4
CO5	Evaluate	the difference between refrigeration and air conditioning.			L4

Unit I:

Introduction: Basic Concepts: System, boundary, Surrounding, control volume, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility – Quasi static Process, Irreversible Process, Causes of Irreversibility.

Unit II

Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – PMM-I, Joule's Experiment – First law of Thermodynamics and applications. Limitations of the First Law – Enthalpy, Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance.

Unit III

Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM-II, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics.

Unit IV

Pure Substances, P-V-T- surfaces, T-S and h-s diagrams, Mollier Charts, Phase Transformations – Triple point at critical state properties during change of phase, Dryness Fraction – Clausius – Clapeyron Equation Property tables. Mollier charts – Various Thermodynamic processes and energy Transfer – Steam Calorimetry.

Unit V

Introduction to Refrigeration: working of Air, Vapour compression, VCR system Components, COP Refrigerants.

Introduction to Air Conditioning: Psychrometric properties & processes – characterization of sensible and latent heat loads – load concepts of SHF.

Requirements of Air standard cycles and vapour Cycles.



Text Books:

1. P.K. Nag, Engineering Thermodynamics, 5/e, Tata McGraw Hill, 2013.
2. Claus Borgnakke Richard E. Sonntag, Fundamentals of Thermodynamics, 7/e, Wiley, 2009.

Reference Books:

1. J.B. Jones, and R.E. Dugan, Engineering Thermodynamics, 1/e, Prentice Hall, 1995.
2. Y.A. Cengel & M.A. Boles, Thermodynamics – An Engineering Approach, 7/e, McGraw Hill, 2010.
3. P. Chattopadhyay, Engineering Thermodynamics, 1/e, Oxford University Press, 2011.
4. CP Arora, Refrigeration and Air-conditioning, 4/e, McGraw Hill, 2021.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Thermodynamics	CO1	3	3		3								2	2
	CO2	3	3		3								2	2
	CO3	2	3		1								3	3
	CO4	3	3		3								3	3
	CO5	3	3		3								2	2

Online Learning Resources:

- <https://www.edx.org/learn/thermodynamics>.
- <https://archive.nptel.ac.in/courses/112/106/112106310>.
- <https://www.youtube.com/watch?v=7NI5P4KqrAs&t=1s>
- https://kp.kiit.ac.in/pdf_files/02/Study-Material_3rd-
- Semester_Winter_2021_Mechanical-Engg.-_Thermal-Engineering-1_Abhijit-Samant.pdf
- <https://www.coursera.org/learn/thermodynamics-intro>

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	18	21.5	3	Apply	L3	PO1 PO2 PO4	Apply (L3) Identify (L3) Develop (L3)	3 3 3
2	18	21.5	3	Analyze	L4	PO1 PO2 PO4	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	16	19	2	Evaluate	L5	PO1 PO2 PO4	Apply (L3) Identify (L3) Develop (L3)	3 3 3
4	16	19	2	Analyze	L4	PO1 PO2 PO4	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	16	19	2	Evaluate	L5	PO1 PO2 PO4	Apply (L3) Identify (L3) Develop (L3)	3 3 3



Justification Statements

CO1: Apply the thermodynamic properties and steam properties to derive the steam-based problems Action Verb: Apply (L3)
PO1 Verb: Apply (L3)
CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Review (L2)
CO1 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyse (L4)
CO1 Action verb is less than level as PO4 verb. Therefore, the correlation is high (3)
CO2: Analyse the laws of thermodynamics to heat-pumps, heat engines, and refrigerators Action Verb: Analyse (L4)
PO1 Verb: Apply (L3) CO2 Action verb is greater than level as PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Review (L2)
CO2 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyse (L4)
CO2 Action verb is as same level as PO4 verb. Therefore, the correlation is high (3)
CO3: Understand the concepts of entropy and availability of the systems Action Verb: Understand (L2)
Action Verb: Understand (L2)
PO1 Verb: Apply (L3)
CO3 Action verb is less than level as PO1 verb by one level. Therefore, the correlation is medium (2)
PO2 Verb: Review (L2)
CO3 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)
PO4 Verb: Analyse (L4)
CO3 Action verb is less than level as PO4 verb by two levels. Therefore, the correlation is low (1) CO4: Analyse the concepts of idea gas equation, gas and vapour mixture and perfect gases Action Verb: Analyse (L4)
PO1 Verb: Apply (L3)
CO4 Action verb is greater than level as PO1 verb. Therefore, the correlation is High (3)
PO2 Verb: Review (L2)
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: Understand (L2)
CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
CO5: Evaluate the TdS equations and Maxwell reactions
Action Verb: Evaluate (L5)
PO1 Verb: Apply (L3)
CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)
PO2 Verb: Review (L2)
CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)
PO7 Verb: Understand (L2)
CO5 Action verb is greater than PO7 verb. Therefore, the correlation is high (3)



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0302	Mechanics of Solids	2	1	0	3

Course Outcomes:

- CO: 1 Apply the concepts of stresses-strains to various machine elements.
CO: 2 Analyze Shear Force and Bending Moment in the beam subjected to different loading conditions.
CO: 3 Evaluate shear stresses and bending stresses in a beam subjected to different loading conditions.
CO: 4 Analyze the deflections of beams and torsional stresses subjected to different loading conditions.
CO: 5 Evaluate the buckling loads for columns and stresses in thin and thick cylinders subjected to pressure.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the concepts of stresses-strains		to various machine elements	L3
CO2	Analyze	Shear Force and Bending Moment in the beam subjected to different loading conditions.			L4
CO3	Evaluate	shear stresses and bending stresses in a beam subjected to different loading conditions.			L5
CO4	Analyze	the deflections of beams and torsional stresses subjected to different loading conditions.			L4
CO5	Evaluate	the buckling loads for columns and stresses in thin and thick cylinders subjected to pressure.			L5

Unit I:

SIMPLE STRESSES & STRAINS : Elasticity and plasticity – Types of stresses & strains–Hooke's law – stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Bars of varying section – composite bars – Temperature stresses- Complex Stresses - Stresses on an inclined plane under different uniaxial and biaxial stress conditions - Principal planes and principal stresses - Mohr's circle - Relation between elastic constants, Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

Unit II

SHEAR FORCE AND BENDING MOMENT: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, u.d.l, uniformly varying loads and combination of these loads – Point of contra flexure – Relation between S.F., B.M and rate of loading at a section of a beam.

Unit III



FLEXURAL STRESSES: Theory of simple bending, Derivation of bending equation, Determination of bending stresses – section modulus of rectangular, circular, I and T sections– Design of simple beam sections.
SHEAR STRESSES: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I and T sections.

Unit IV

DEFLECTION OF BEAMS: Bending into a circular arc – slope, deflection and radius of curvature – Differential equation for the elastic line of a beam – Double integration and Macaulay's methods – Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, UDL and UVL. Mohr's theorem and Moment area method – application to simple cases.

TORSION: Introduction-Derivation- Torsion of Circular shafts- Pure Shear-Transmission of power by circular shafts, Shafts in series, Shafts in parallel.

Unit V

THIN AND THICK CYLINDERS: Thin seamless cylindrical shells – Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains – changes in dia, and volume of thin cylinders– Thin spherical shells. Wire wound thin cylinders. Lamé's equation – cylinders subjected to inside & outside pressures – compound cylinders.

COLUMNS: Buckling and Stability, Columns with Pinned ends, Columns with other support Conditions, Limitations of Euler's Formula, Rankine's Formula.

Text Books:

1. GH Ryder, Strength of materials, Palgrave Macmillan publishers India Ltd, 1961.
2. B.C. Punmia, Strength of materials, 10/e, Lakshmi publications Pvt. Ltd, New Delhi, 2018.

Reference Books:

1. Gere & Timoshenko, Mechanics of materials, 2/e, CBS publications, 2004.
2. U.C. Jindal, Strength of Materials, 2/e, Pearson Education, 2017.
3. Timoshenko, Strength of Materials Part – I & II, 3/e, CBS Publishers, 2004.
4. Andrew Pytel and Ferdinand L. Singer, Strength of Materials, 4/e, Longman Publications, 1990.
5. Popov, Mechanics of Solids, 2/e, New Pearson Education, 2015.

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc19_ce18/preview.
- https://youtube/iY_ypsychVNY?si=310htc4ksTQJ8Fv6.
- https://www.youtube.com/watch?v=WEy939Rkd_M&t=2s
- <https://www.classcentral.com/course/swayam-strength-of-materials-iitm-184204>
- <https://www.coursera.org/learn/mechanics-1>
- <https://www.edx.org/learn/engineering/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-1-linear-elastic-behavior>
- <https://archive.nptel.ac.in/courses/112/107/112107146/>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Mechanics of Solids	CO1	3	3	3									3	3
	CO2	3	3	3									3	3
	CO3	3	3	3									3	3
	CO4	3	3	3									3	3
	CO5	3	3	3									3	3

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)



Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	18	21.5	3	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
2	18	21.5	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	16	19	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
4	16	19	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	16	19	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
	84	100						

Justification Statements:

CO1: Apply the concepts of stresses-strains to various machine elements.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO2: Analyze Shear Force and Bending Moment in the beam subjected to different loading conditions.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Evaluate shear stresses and bending stresses in a beam subjected to different loading conditions.

Action Verb: Evaluate (L5)

PO1Verb: Apply (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the deflections of beams and torsional stresses subjected to different loading conditions.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)



CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Evaluate the buckling loads for columns and stresses in thin and thick cylinders subjected to pressure.

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0303	Material Science and Metallurgy	2	1	0	3

Course Outcomes:

- CO: 1 Understand the crystalline structure of different metals and stability of phases in different alloy systems.
- CO: 2 Understand the behavior of ferrous and nonferrous metals and alloys.
- CO: 3 Analyze the effect of heat treatment, addition of alloying elements and TTT Diagrams.
- CO: 4 Apply the process of metal powders and applications of powder metallurgy in manufacturing methods.
- CO: 5 Analyze the properties and applications of ceramic, composites, nano and smart materials.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the crystalline structure of different metals and stability of phases in different alloy systems			L2
CO2	Understand	the behavior of ferrous and nonferrous metals and alloys			L2
CO3	Analyze	the effect of heat treatment, addition of alloying elements and TTT Diagrams			L4
CO4	Apply	the process of metal powders and applications of powder metallurgy		in manufacturing methods.	L3
CO5	Analyze	the properties and applications of ceramic, composites nano and smart materials			L4

Unit I:

Structure of Metals and Constitution of alloys: Crystallization of metals, Packing Factor - SC, BCC, FCC & HCP line density, plane density. Grain and grain boundaries, effect of grain boundaries determination of grain size. Imperfections, Slip and Twinning. Necessity of alloying, types of solid solutions, Hume-Rothery's rules, intermediate alloy phases, and electron compounds.

Equilibrium Diagrams: Experimental methods of construction of equilibrium diagrams, Isomorphous alloy systems, equilibrium cooling and heating of alloys, Lever rule, coring miscibility gaps, eutectic systems, congruent melting intermediate phases, peritectic reaction. Transformations in the solid state – allotropy, eutectoid, peritectoid reactions, phase rule, relationship between equilibrium diagrams and properties of alloys. Study of binary phase diagrams such as Cu-Ni and Fe-Fe₃C.

Unit II

Ferrous metals and alloys: Structure and properties of White Cast iron, Malleable Cast iron, grey cast iron, Spheroidal graphite cast iron, Alloy cast iron. Classification of steels, structure and properties of plain carbon steels, Low alloy steels, Hadfield manganese steels, tool and die steels.

Non-ferrous Metals and Alloys: Structure and properties of copper and its alloys, Aluminum and its alloys, Titanium and its alloys, Magnesium and its alloys, Super alloys.

Unit III



Heat treatment of Steels: Effect of alloying elements on Fe-Fe₃C system, annealing, normalizing, hardening, TTT diagrams, tempering, hardenability, surface - hardening methods, age hardening treatment, Cryogenic treatment.

Unit IV

Powder Metallurgy: Basic processes- Methods of producing metal powders- milling atomization- Granulation-Reduction-Electrolytic Deposition. Compacting methods – Sintering - Methods of manufacturing sintered parts. Secondary operations, Applications of powder metallurgical products.

Unit V

Ceramic and Advanced materials: Crystalline ceramics, glasses, cermets, abrasive materials, Classification of composites, manufacturing methods, particle reinforced composites, fiber reinforced composites, PMC, MMC, CMC and CCCs. Introduction to Nanomaterials and smart materials.

Text Books:

1. S.H.Avner, Introduction to Physical Metallurgy, 2/e, Tata McGraw- Hill, 1997.
2. Donald R. Askeland, Essentials of Materials science and Engineering, 4/e, CL Engineering publications, 2018.

Reference Books:

1. Dr. V.D. Kodgire, Material Science and Metallurgy, 39/e, Everest Publishing House, 2017.
2. V. Raghavan, Material Science and Engineering, 5/e, Prentice Hall of India, 2004.
3. William D. Callister Jr, Materials Science and Engineering: An Introduction, 8/e, John Wiley and Sons, 2009.
4. George E. Dieter, Mechanical Metallurgy, 3/e, McGraw-Hill, 2013.
5. Yip-Wah Chung, Introduction to Material Science and Engineering, 2/e, CRC Press, 2022.
6. A V K Suryanarayana, Material Science and Metallurgy, B S Publications, 2014.
7. U. C. Jindal, Material Science and Metallurgy, 1/e, Pearson Publications, 2011.

Online Learning Resources:

- <https://archive.nptel.ac.in/courses/113/106/113106032/>
- <https://www.edx.org/learn/mechanics/massachusetts-institute-of-technology-mechanical-behavior-of-materials-part-3-time-dependent-behavior>
- <https://www.youtube.com/watch?v=9Sf278j1GTU>
- <https://www.coursera.org/learn/fundamentals-of-materials-science>
- <https://www.coursera.org/learn/material-behavior>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Material Science and Metallurgy	CO1	2	2				2						2	2
	CO2	2	2				2						2	2
	CO3	3	3				3						3	3
	CO4	3	3				3						3	3
	CO5	3	3				3						3	3



Correlation matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	19	29	3	Understand	L2	PO1 PO2 PO6	Identify-L3 Review-L2 Thumb Rule	2 3 2
2	15	23	3	Understand	L2	PO1 PO2 PO6	Identify-L3 Review-L2 Thumb Rule	2 3 2
3	8	12	1	Analyze	L4	PO1 PO2 PO6	Apply-L3 Review-L2 Thumb Rule	3 3 3
4	10	15	2	Apply	L3	PO1 PO2 PO6	Apply-L3 Review-L2 Thumb Rule	3 3 3
5	12	18	2	Analyze	L4	PO1 PO2 PO6	Apply-L3 Review-L2 Thumb Rule	3 3 3

Justification Statements:

CO1: Understand the crystalline structure of different metals and stability of phases in different alloy systems

Action Verb: **Understand** (L2)

PO1 Verb: **Identify** (L3)

CO1 Action verb is less than as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Review** (L2)

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO6 Verb: **Thumb rule**

CO1 Action verb is less than as PO6 verb. Therefore, the correlation is medium (2)

CO2: Understand the behavior of ferrous and nonferrous metals and alloys

Action Verb: **Understand** (L2)

PO1 Verb: **Identify** (L3)

CO2 Action verb is less than as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Review** (L2)

CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO6 Verb: **Thumb rule**

CO2 Action verb is less than as PO6 verb. Therefore, the correlation is medium (2)

CO3: Analyze the effect of heat treatment, addition of alloying elements and TTT Diagrams

Action Verb: **Analyze** (L4)

PO1 Verb: **Apply** (L3)

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review** (L2)

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO6 Verb: **Thumb rule**

CO3 Action verb is same level (greater) as PO6 verb. Therefore, the correlation is high (3)



CO4: Apply the process of metal powders and applications of powder metallurgy in manufacturing methods

Action Verb: **Apply** (L3)

PO1 Verb: **Identify** (L3)

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review** (L2)

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO6 Verb: **Thumb rule**

CO4 Action verb is same level as PO6 verb. Therefore, the correlation is high (3)

CO5: Analyze the properties and applications of ceramic, composites, Nano and smart materials

Action Verb: **Analyze** (L4)

PO1 Verb: **Apply** (L3)

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Review** (L2)

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO6 Verb: **Thumb rule**

CO5 Action verb is same level (greater) as PO6 verb. Therefore, the correlation is high (3)



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0304	Mechanics of Solids and Materials Science Lab	0	0	2	1

Course Outcomes:

- CO: 1 Evaluate the tensile, hardness, impact, bending, shear and torsional properties of materials.
- CO: 2 Evaluate the stiffness and tension on springs.
- CO: 3 Analyze the surface defects like cracks and porosity on metals using liquid penetration test.
- CO: 4 Understand the various microstructures of metals, steels and cast irons.
- CO: 5 Understand the various microstructures of nonferrous alloys and heat-treated steels.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Evaluate	the tensile, hardness, impact, bending, shear and torsional properties of materials			L5
CO2	Evaluate	the stiffness and tension on springs			L4
CO3	Analyze	the surface defects like cracks and porosity	on metals using liquid penetration test		L5
CO4	Understand	the various microstructures of metals, steels and cast irons			L2
CO5	Understand	the various microstructures of nonferrous alloys and heat-treated steels.			L2
CO6	Analyze	the Hardenability of steels	by using Jominy End Quench Test		L4

NOTE: Any 6 experiments from each section A and B.

A) MECHANICS OF SOLIDS LAB:

1. Tensile test
2. Bending test on
 - a) Simply supported beam
 - b) Cantilever beam
3. Torsion test
4. Hardness test
 - a) Brinell's hardness test
 - b) Rockwell hardness test
 - c) Vickers hardness test
5. Test on springs
6. Impact test
 - a) Charpy test
 - b) Izod test
7. Punch shear test
8. Liquid penetration test

B) MATERIAL SCIENCE LAB:



1. Preparation and study of the Microstructure of pure metals.
2. Preparation and study of the Microstructure of Mild steel, medium carbon steels, and High carbon steels.
3. Study of the Microstructures of Cast Irons.
4. Study of the Microstructures of Non-Ferrous alloys.
5. Study of the Microstructures of Heat-treated steels.
6. Hardenability of steels by Jominy End Quench Test

Virtual lab:

1. To investigate the principal stresses σ_a and σ_b at any given point of a structural element or machine component when it is in a state of plane stress. (<https://virtual-labs.github.io/exp-rockwell-hardness-experiment-iiith/objective.html>)
2. To find the impact resistance of mild steel and cast iron. (<https://sm-nitk.vlabs.ac.in/exp/izod-impact-test>).
3. To find the impact resistance of mild steel. (<https://sm-nitk.vlabs.ac.in/exp/charpy-impact-test/index.html>)
4. To find the Rockwell hardness number of mild steel, cast iron, brass, aluminum and spring steel etc. (<https://sm-nitk.vlabs.ac.in/exp/rockwell-hardness-test>)
5. To determine the indentation hardness of mild steel, brass, aluminum etc. using Vickers hardness testing machine. (<https://sm-nitk.vlabs.ac.in/exp/vickers-hardness-test>).

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Mechanics of Solids and Materials Science Lab	CO1	3	3							3			3	3
	CO2	3	3							3			3	3
	CO3	3	3							3			3	3
	CO4	2	2							2			2	2
	CO5	2	2							2			2	2
	CO6	3	3							3			3	3

CO	Cos		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	Evaluate	L5	PO1	Apply (L3)	3
			PO2	Identify (L3)	3
			PO9	Thumb Rule	3
2	Evaluate	L5	PO1	Apply (L3)	3
			PO2	Identify (L3)	3
			PO9	Thumb Rule	3
3	Analyze	L4	PO1	Apply (L3)	3
			PO2	Identify (L3)	3
			PO9	Thumb Rule	3
4	Understand	L2	PO1	Apply (L3)	2
			PO2	Identify (L3)	2
			PO9	Thumb Rule	3
5	Understand	L2	PO1	Apply (L3)	2
			PO2	Identify (L3)	2
			PO9	Thumb Rule	3
6	Analyze	L4	PO1	Apply (L3)	3
			PO2	Identify (L3)	3
			PO9	Thumb Rule	3



Justification Statements:

CO1: Evaluate the tensile, hardness, impact, bending, shear and torsional properties of materials
Action Verb: **Evaluate** (L5)

PO1 Verb: **Apply** (L3)

CO1 Action verb is same level (greater) than as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Identify** (L3)

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb rule**

CO1 Action verb is same level (greater) than as PO9 verb. Therefore, the correlation is high (3)

CO2: Evaluate the stiffness and tension on springs

Action Verb: **Evaluate** (L5)

PO1 Verb: **Apply** (L3)

CO2 Action verb is same level (greater) than as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Identify** (L3)

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb rule**

CO2 Action verb is same level (greater) than as PO9 verb. Therefore, the correlation is high (3)

CO3: Analyze the surface defects like cracks and porosity on metals using liquid penetration test s
Action Verb: **Analyse** (L4)

PO1 Verb: **Apply** (L3)

CO3 Action verb is same level (greater) than as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Identify** (L3)

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb rule**

CO3 Action verb is same level (greater) than as PO9 verb. Therefore, the correlation is high (3)

CO4: Understand the various microstructures of metals, steels and cast irons

Action Verb: **Apply** (L3)

PO1 Verb: **Apply** (L3)

CO4 Action verb is less than as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Identify** (L3)

CO4 Action verb is less than as PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: **Thumb rule**

CO4 Action verb is same level as PO6 verb. Therefore, the correlation is high (3)

CO5: Understand the various microstructures of nonferrous alloys and heat treated steels

PO1 Verb: **Apply** (L3)

CO5 Action verb is less than as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Identify** (L3)

CO5 Action verb is less than as PO2 verb. Therefore, the correlation is medium (2)

PO6 Verb: **Thumb rule**

CO5 Action verb is same level as PO6 verb. Therefore, the correlation is high (3)

CO6: Analyze the Hardenability of steels by using Jominy End Quench Test



Action Verb: **Analyse** (L4)

PO1 Verb: **Apply** (L3)

CO6 Action verb is same level (greater) than as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify** (L3)

CO6 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO9 Verb: **Thumb rule**

CO6 Action verb is same level (greater) than as PO9 verb. Therefore, the correlation is high (3)



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0305	Computer-Aided Machine Drawing	0	0	3	1.5

Course Outcomes:

- CO: 1 Understand the concepts of conventional representations of materials and machine components.
- CO: 2 Apply the drawing skills to design (build/develop) the machine elements and simple components.
- CO: 3 Create solid models and sectional views of machine components.
- CO: 4 Analyze the assembly views for the part drawing of the machine and engine parts.
- CO: 5 Understand the representation of limits, fits and tolerances for mating parts.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts of conventional representations of materials and machine components			L2
CO2	Apply	the drawing skills to design (build / develop) the machine elements and simple components			L3
CO3	Create	solid models and sectional views of machine components			L6
CO4	Analyze	the assembly views for the part drawing of the machine and engine parts			L4
CO5	Understand	the representation of limits, fits and tolerances for mating parts			L2

The following are to be done by any 2D software package

Conventional representation of materials and components:

Detachable joints: Drawing of thread profiles, hexagonal and square-headed bolts and nuts, bolted joint with washer and locknut, stud joint, screw joint and foundation bolts.

Riveted joints: Drawing of rivet, lap joint, butt joint with single strap, single riveted, double riveted double strap joints.

Welded joints: Lap joint and T joint with fillet, butt joint with conventions.

Keys: Taper key, sunk taper key, round key, saddle key, feather key, woodruff key.

Couplings: rigid – Muff, flange; flexible – bushed pin-type flange coupling, universal coupling, Oldham's coupling.

The following exercises are to be done by any 3D software package:

Sectional views:

Creating solid models of complex machine parts and sectional views.

Assembly drawings: (Any four of the following using solid model software)

Lathe tool post, tool head of shaping machine, tail-stock, machine vice, gate valve, carburetor, piston, connecting rod, eccentric, screw jack, plumber block, axle bearing, pipe vice, clamping device, Geneva cam, universal coupling.

Production drawing:



Representation of limits, fits and tolerances for mating parts. Use any four parts of above assembly drawings and prepare manufacturing drawing with dimensional and geometric tolerances

Text Books:

1. Machine Drawing by K.L. Narayana, P. Kannaiah and K.Venkat Reddy, New Age International Publishers, 3/e, 2014
2. Machine drawing by N. Sideswar, P. Kannaiah, V.V.S. Sastry, TMH Publishers. 2014

Reference Books:

1. Cecil Jensen, Jay Helsel and Donald D. Voisinet, Computer Aided Engineering Drawing, Tata McGraw-Hill, NY, 2000.
2. James Barclay, Brain Griffiths, Engineering Drawing for Manufacture, Kogan Page Science, 2003.
3. N.D. Bhatt, Machine Drawing, Charotar Publishers, 50/e, 2014.

Online Learning Resources:

- <https://eedocs.wordpress.com/wp-content/uploads/2014/02/machinedrawing.pdf>
- <https://archive.nptel.ac.in/courses/112/105/112105294/>
- https://www.edx.org/learn/engineering/dassault-systemes-solidworks-solidworks-cad-fundamentals?index=product&queryID=c90b35a82a6ef58b0d6f89679c63f6a1&position=2&linked_from=autocomplete&c=autocomplete
- https://www.youtube.com/watch?v=0bQkS3_3Fq4

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Computer Aided Machine Drawing	CO1	3		2		3				2			2	2
	CO2	3		2		3				2			2	2
	CO3	3		2		3				2			2	2
	CO4	3		2		3				2			2	2
	CO5	3		2		3				2			2	2

Correlation matrix

CO	Cos		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Verb	BTL			
1	Understand	L2	PO1	Apply (L3)	2
			PO3	Develop (L3)	2
			PO5	Apply (L3)	2
			PO9	Thumb Rule	3
2	Apply	L3	PO1	Apply (L3)	3
			PO3	Develop (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	3
3	Create	L6	PO1	Apply (L3)	3
			PO3	Develop (L3)	3
			PO5	Create (L6)	3
			PO9	Thumb Rule	3
4	Analyze	L4	PO1	Apply (L3)	3
			PO3	Develop (L3)	3
			PO5	Apply (L3)	3
			PO9	Thumb Rule	3



5	Understand	L2	PO1	Apply (L3)	2
			PO3	Develop (L3)	2
			PO5	Apply (L3)	2
			PO9	Thumb Rule	3

Justification Statements:

CO1: Understand the concepts of conventional representations of materials and machine components.

Action Verb: Understand (L2)

PO1Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: Develop (L3)

CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)

PO5 Verb: Apply (L3)

CO1 Action verb is less than PO5 verb by one level. Therefore, the correlation is medium (2)

CO1: Computer-Aided Machine Drawing involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3).

CO2: Apply the drawing skills to design (build/develop) the machine elements and simple components.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: Apply (L3)

CO2 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO2: Computer-Aided Machine Drawing involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3).

CO3: Create solid models and sectional views of machine components.

Action Verb: Create (L6)

PO1Verb: Apply (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: Create (L6)

CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO3: Computer-Aided Machine Drawing involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3).

CO4: Analyze the assembly views for the part drawing of the machine and engine parts.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: Apply (L3)

CO4 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO4: Computer-Aided Machine Drawing involves creating visual representations and technical



drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3).

CO5: Understand the representation of limits, fits and tolerances for mating parts.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO5 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: Develop (L3)

CO5 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)

PO5 Verb: Apply (L3)

CO5 Action verb is less than PO5 verb by one level. Therefore, the correlation is medium (2)

CO5: Computer-Aided Machine Drawing involves creating visual representations and technical drawings to communicate design ideas, concepts and specifications. Therefore, the correlation is high (3).



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0402	Embedded Systems & IoT	0	0	3	1.5

Course Outcomes:

- CO: 1 Analyze the measurement of analog signals from Sensors using ADC and PWM
 CO: 2 Design Full duplex communication links using hyper terminal for reliable data exchange.
 CO: 3 Analyze the control of Actuators using analog GPIOs on Arduino platforms.
 CO: 4 Understand the use of IDEs like Arduino IDE and Python based IDEs for Raspberry pi to trace and debug code.
 CO: 5 Analyze IoT solutions by interfacing with online services and public APIs for data acquisition.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the measurement of analog signals from Sensors		using ADC and PWM	L4
CO2	Design	Full duplex communication links using hyper terminal	for reliable data exchange.		L6
CO3	Analyze	the control of Actuators	using analog GPIOs	on Arduino platforms.	L4
CO4	Understand	the use of IDEs like Arduino IDE and Python based IDEs for Raspberry pi		to trace and debug code.	L2
CO5	Analyze	IoT solutions by interfacing with online services and public APIs	for data acquisition		L4

Embedded Systems Experiments:(Any 5 experiments from the following)

1. Measure Analog signal from Temperature Sensor.(CO1)
2. Generate PWM output.(CO1)
3. Drive single character generation on Hyper Terminal.(CO2)
4. Drive a given string on Hyper Terminal.(CO2)
5. Full duplex Link establishment using Hyper terminal.(CO2)
6. Drive a given value on a 8bit DAC consisting of SPI.(CO2)
7. Drive Stepper motor using Analog GPIOs.(CO3)
8. Drive Accelerometer and Display the readings on Hyper Terminal.(CO3)

COMPONENTS/BOARDS:1.ArduinoDuemilanoveBoard2.ArduinoSoftwareIDE.

Text Books:

1. Embedded Systems Architecture-By Tammy Noergaard, Elsevier Publications, 2013.
2. Embedded Systems-By Shibu.K.V-Tata McGrawHill Education Private Limited,2013.
3. Embedded System Design, FrankVahid,TonyGivargis,JohnWileyPublications,2013.
4. EmbeddedSystems-LylaB.Das-PearsonPublications,2013.

Internet of Things Experiments:(Any5experimentsfromthefollowing)

1. Getting started with Raspberry Pi, Install Raspbian on your SD card.(CO4)
2. Python-based IDE (integrated development environments) for the Raspberry Pi and how to trace and debug Python code on the device.(CO4)



Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

3. Using Raspberry pi
 - a. Calculate the distance using distance sensor.
 - b. Basic LED functionality.(C05)
4. Raspberry Pi interact with online services through the use of public APIs and SDKs.(C05)
5. Study and Install IDE of Arduino and different types of Arduino.(C04)
6. Study and Implement Zigbee Protocol using Arduino/Raspberry Pi.(C05)
7. Calculate the distance using distance sensor Using Arduino.(C05)
8. Basic LED functionality Using Arduino and Node MCU.(C05)
9. Calculate the moisture content in the soil using Arduino and Node MCU.(C05)
10. Calculate the distance using distance sensor Using Node MCU.(C05)
11. Basic LED functionality Using Node MCU.(C05)

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
Embedde d Systems & IoT	CO1	3	3	3	3	3							2	2	
	CO2	3		3	2	3							3	2	
	CO3	3	3	3	2	3							2	2	
	CO4	2		2		2								3	
	CO5	3		3	3	3							2	2	

Correlation matrix

S.No	Course Outcomes(CO)		Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Co's Action verb	BTL			
1	Analyze	L4	PO1, PO2, PO3, PO4, PO5	PO1: Apply (L3) PO2:Identify(L3) PO3: Develop (L3) PO4:Analyze(L4) PO5:Apply(L3)	3 3 3 3 3
2	Design	L3	PO1, PO3, PO4, PO5	PO1: Apply (L3) PO3: Develop (L3) PO4:Analyze(L4) PO5:Apply(L3)	3 3 2 3
3	Analyze	L4	PO1, PO2, PO3, PO4, PO5	PO1: Apply (L3) PO2:Identify(L3) PO3: Develop (L3) PO4:Interpret(L5) PO5:Apply(L3)	3 3 3 2 3
4	Understand	L2	PO1, PO3, PO5	PO1: Apply (L3) PO3: Develop (L3) PO5:Apply(L3)	2 2 2
5	Analyze	L4	PO1, PO3, PO4, PO5	PO1: Apply (L3) PO3: Develop (L3) PO4:Analyze(L4) PO5:Apply(L3)	3 3 3 3

JUSTIFICATION STATEMENTS

C01: Analyze the measurement of analog signals from Sensors using ADC and PWM

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

C01 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

PO2 Verbs: Identify (L3)

C01 Action Verb is greater than PO2 verb by one level; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3)

C01 Action Verb is greater than PO3 verb by one level; Therefore correlation is high (3).

PO4 Verbs: Analyze (L4)

C01 Action Verb is equal to PO4 verb; Therefore correlation is high (3).

PO5 Verbs: Apply (L3)

C01 Action Verb is greater than PO5 verb by one level; Therefore, correlation is high (3).

C02: Design Full duplex communication links using hyper terminal for reliable data exchange.



Action Verb: Design (L3)

PO1 Verbs: Apply (L3)

CO2 Action Verb is equal to PO1 verb ; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3)

CO2 Action Verb is equal to PO3 verb ; Therefore, correlation is high (3).

PO4 Verbs: Analyze (L4)

CO2 Action Verb is less than PO4 verb by one level; Therefore correlation is moderate (2).

PO5 Verbs: Apply (L3)

CO2 Action Verb is equal to PO5 verb ; Therefore, correlation is high (3).

CO3: Analyze the control of Actuators using analog GPIOs on Arduino platforms.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO3 Action Verb is equal to PO1 verb ; Therefore, correlation is high (3).

PO2 Verbs: Identify (L3)

CO3 Action Verb is equal to PO2 verb ; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3)

CO3 Action Verb is equal to PO3 verb ; Therefore, correlation is high (3).

PO4 Verbs: Interpret (L5)

CO2 Action Verb is less than PO4 verb by one level; Therefore correlation is moderate (2).

PO5 Verbs: Apply (L3)

CO3 Action Verb is equal to PO5 verb ; Therefore, correlation is high (3).

CO4: Understand the use of IDEs like Arduino IDE and Python based IDEs for Raspberry pi to trace and debug code.

Action Verb: Understand (L2)

PO1 Verbs: Apply (L3)

CO4 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO3 Verbs: Develop (L3)

CO4 Action Verb is less than PO3 verb by one level; Therefore correlation is moderate (2).

PO5 Verbs: Apply (L3)

CO4 Action Verb is less than PO5 verb by one level; Therefore correlation is moderate (2).

CO5: Analyze IoT solutions by interfacing with online services and public APIs for data acquisition

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3)

CO5 Action Verb is equal to PO1 verb ; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3)

CO5 Action Verb is equal to PO3 verb ; Therefore, correlation is high (3).

PO4 Verbs: Analyze (L4)

CO5 Action Verb is equal to PO4; Therefore correlation is high (3).

PO5 Verbs: Apply (L3)

CO5 Action Verb is equal to PO5 verb ; Therefore, correlation is high (3).



Year: II

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ASC0501	Python Programming	0	1	2	2

Course Outcomes:

- CO: 1 Understand the Basic concepts of python programming to build scripts in IDLE.
CO: 2 Apply the modularity techniques to invoke user defined functions.
CO: 3 Apply the concept of Dictionaries, Tuples and sets to perform operations on data.
CO: 4 Analyze the file concepts and oops paradigms to manage data.
CO: 5 Apply the concepts of JSON and XML for data processing

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	Basic concepts of python programming		to build scripts in IDLE	L2
CO2	Apply	the modularity techniques		to invoke user defined functions	L3
CO3	Apply	the concept of Dictionaries, Tuples and sets		to perform operations on data.	L3
CO4	Analyze	the file concepts and oops paradigms.		to manage data	L4
CO5	Apply	the concepts of JSON and XML		for data processing	L3

UNIT - I	9Hrs
History of Python Programming Language, Thrust Areas of Python, Installing Anaconda Python Distribution, Installing and Using Jupyter Notebook. Parts of Python Programming Language: Identifiers, Keywords, Statements and Expressions, Variables, Operators, Precedence and Associativity, Data Types, Indentation, Comments, Reading Input, Print Output, Type Conversions, the type () Function and Is Operator, Dynamic and Strongly Typed Language. Control Flow Statements: if statement, if-else statement, if...elif...else, Nested if statement, while Loop, for Loop, continue and break Statements, Catching Exceptions Using try and except Statement. Sample Experiments: - Write a program to find the largest element among three Numbers. - Write a Program to display all prime numbers within an interval - Write a program to swap two numbers without using a temporary variable. - Demonstrate the following Operators in Python with suitable examples. i) Arithmetic Operators ii) Relational Operators iii) Assignment Operators iv) Logical Operators v) Bit wise Operators vi) Ternary Operator vii) Membership Operators viii) Identity Operators - Write a program to add and multiply complex numbers - Write a program to print multiplication table of a given number.	
UNIT - II	9 Hrs
Functions: Built-In Functions, Commonly Used Modules, Function Definition and Calling the function, return Statement and void Function, Scope and Lifetime of Variables, Default Parameters, Keyword Arguments, *args and **kwargs, Command Line Arguments. Strings: Creating and Storing Strings, Basic String Operations, Accessing Characters in String by Index Number, String Slicing and Joining, String Methods, Formatting Strings. Lists: Creating Lists, Basic List Operations, Indexing and Slicing in Lists, Built-In Functions Used on	



Lists, List Methods, del Statement.

Sample Experiments:

7. Write a program to define a function with multiple return values.
8. Write a program to define a function using default arguments.
9. Write a program to find the length of the string without using any library functions.
10. Write a program to check if the substring is present in a given string or not.
11. Write a program to perform the given operations on a list:
i. Addition ii. Insertion iii. slicing
12. Write a program to perform any 5 built-in functions by taking any list.

UNIT – III

9 Hrs

Dictionaries: Creating Dictionary, Accessing and Modifying key:value Pairs in Dictionaries, Built-In Functions Used on Dictionaries, Dictionary Methods, del Statement.

Tuples and Sets: Creating Tuples, Basic Tuple Operations, tuple() Function, Indexing and Slicing in Tuples, Built-In Functions Used on Tuples, Relation between Tuples and Lists, Relation between Tuples and Dictionaries, Using zip() Function, Sets, Set Methods, Frozenset.

Sample Experiments:

13. Write a program to create tuples (name, age, address, college) for at least two members and concatenate the tuples and print the concatenated tuples.
14. Write a program to count the number of vowels in a string (No control flow allowed).
15. Write a program to check if a given key exists in a dictionary or not.
16. Write a program to add a new key-value pair to an existing dictionary.
17. Write a program to sum all the items in a given dictionary.

UNIT – IV

9 Hrs

Files: Types of Files, Creating and Reading Text Data, File Methods to Read and Write Data, Reading and Writing Binary Files, Pickle Module, Reading and Writing CSV Files, Python os and os.path Modules.

Object-Oriented Programming: Classes and Objects, Creating Classes in Python, Creating Objects in Python, Constructor Method, Classes with Multiple Objects, Class Attributes Vs Data Attributes, Encapsulation, Inheritance, Polymorphism.

Sample Experiments:

18. Write a program to sort words in a file and put them in another file. The output file should have only lower-case words, so any upper-case words from source must be lowered.
19. Python program to print each line of a file in reverse order.
20. Python program to compute the number of characters, words and lines in a file.
21. Write a program to create, display, append, insert and reverse the order of the items in the array.
22. Write a program to add, transpose and multiply two matrices.
23. Write a Python program to create a class that represents a shape. Include methods to calculate its area and perimeter. Implement subclasses for different shapes like circle, triangle, and square.

UNIT – V

9Hrs

Introduction to Data Science: Functional Programming, JSON and XML in Python, NumPy with Python, Pandas.

Sample Experiments:

24. Python program to check whether a JSON string contains complex object or not.
25. Python Program to demonstrate NumPy arrays creation using array () function.
26. Python program to demonstrate use of ndim, shape, size, dtype.
27. Python program to demonstrate basic slicing, integer and Boolean indexing.
28. Python program to find min, max, sum, cumulative sum of array
29. Create a dictionary with at least five keys and each key represent value as a list where this list



contains at least ten values and convert this dictionary as a pandas data frame and explore the data through the data frame as follows:

- Apply head () function to the pandas data frame
- Perform various data selection operations on Data Frame

30. Select any two columns from the above data frame, and observe the change in one attribute with respect to other attribute with scatter and plot operations in matplotlib

Reference Books:

- Gowrishankar S, Veena A., Introduction to Python Programming, CRC Press.
- Python Programming, S Sridhar, J Indumathi, V M Hariharan, 2nd Edition, Pearson, 2024
- Introduction to Programming Using Python, Y. Daniel Liang, Pearson.

Online Learning Resources/Virtual Labs

- <https://www.coursera.org/learn/python-for-applied-data-science-ai>
- <https://www.coursera.org/learn/python?specialization=python#syllabus>

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	2		2							1	
CO2	3	3	3	2	3								2
CO3	3	3	3	2	3								2
CO4	3	3	3	3	3						2		
CO5	3	3	3	2	3								2

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1	9	20	2	CO1 : Understand	L2	PO1 PO2 PO3 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO5: Apply (L3)	2 3 2 2
2	9	20	2	CO2 : Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply (L3)	3 3 3 2 3
3	9	20	2	CO3 : Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply (L3)	3 3 3 2 3
4	9	20	2	CO4 : Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO11	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply (L3) Thumb Rule	3 3 3 3 3 2
5	9	20	2	CO5 : Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply(L3) PO2: Review(L2) PO3: Develop (L3) PO4: Analyze(L4) PO5: Apply (L3)	3 3 3 2 3
	53	100 %						

Justification Statements:

CO1: Understand the Basic concepts of python programming to build scripts in IDLE.

Action Verb : Understand(L2)

PO1 Verb : Apply(L3)



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C01 Action verb is less than P01 verb by one level. Therefore the correlation is moderate (2)

P02 Verb : Review(L2)

C01 Action verb is same as P02 verb. Therefore the correlation is high (3)

P03 Verb : Develop(L3)

C01 Action verb is less than P03 verb by one level. Therefore the correlation is moderate (2)

P05 Verb : Apply(L3)

C01 Action verb is less than P05 verb by one level. Therefore the correlation is moderate (2)

C02: Apply the modularity techniques to invoke user defined functions.

Action Verb : Apply (L3)

P01: Apply(L3)

C02 Action verb is same as P01 verb. Therefore the correlation is high (3)

P02 Verb : Review(L2)

C02 Action verb is greater than P02 verb. Therefore the correlation high (3)

P03 Verb : Develop (L3)

C02 Action verb same as P03 verb. Therefore the correlation high (3)

P04 Verb : Analyze(L4)

C02 Action verb is less than P04 verb by one level. Therefore the correlation is moderate (2)

P05 Verb : Apply(L3)

C02 Action verb is same as P05 verb. Therefore the correlation is high (3)

C03: Apply the concept of Dictionaries, Tuples and sets to perform operations on data.

Action Verb : Apply(L3)

P01: Apply(L3)

C03 Action verb is same as P01 verb. Therefore the correlation is high (3)

P02 Verb : Review(L2)

C03 Action verb is greater than P02 verb. Therefore the correlation high (3)

P03 Verb : Develop (L3)

C03 Action verb same as P03 verb. Therefore the correlation high (3)

P04 Verb : Analyze(L4)

C03 Action verb is less than P04 verb by one level. Therefore the correlation is moderate (2)

P05 Verb : Apply(L3)

C03 Action verb is same as P05 verb. Therefore the correlation is high (3)

C04: Analyze the file concepts and oops paradigms to manage data.

Action Verb: Analyze(L4)

P01: Apply(L3)

C03 Action verb is greater than P01 verb. Therefore the correlation is high (3)

P02 Verb : Review(L2)

C03 Action verb is greater than P02 verb. Therefore the correlation high (3)

P03 Verb : Develop (L3)

C03 Action verb is greater than P03 verb. Therefore the correlation high (3)

P04 Verb : Analyze(L4)

C03 Action verb is same as P04 verb. Therefore the correlation is high (3)

P05 Verb : Apply(L3)

C03 Action verb is greater than P05 verb. Therefore the correlation is high (3)

P011: Thumb rule

To solve the real time problems oops and file concepts are necessary for data security. Therefore the correlation is medium(2)

C05: Apply the concepts of JSON and XML for data processing.

Action Verb : Apply(L3)

P01: Apply(L3)

C03 Action verb is same as P01 verb. Therefore, the correlation is high (3)

P02 Verb : Review(L2)

C03 Action verb is greater than P02 verb. Therefore the correlation high (3)

P03 Verb : Develop (L3)

C03 Action verb same as P03 verb. Therefore the correlation high (3)

P04 Verb : Analyze(L4)

C03 Action verb is less than P04 verb by one level. Therefore the correlation is moderate (2)

P05 Verb : Apply(L3)

C03 Action verb is same as P05 verb. Therefore the correlation is high (3)



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AK23 Regulations

B. Tech – II Year II Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	HM	23AHM0301	Industrial Management	2	0	0	2	30	70	100
2	BS	23ABS9914	Complex Variables, Probability and Statistics	2	1	0	3	30	70	100
3	PC	23APC0306	Manufacturing processes	2	1	0	3	30	70	100
4	PC	23APC0307	Fluid Mechanics & Hydraulic Machines	2	1	0	3	30	70	100
5	PC	23APC0308	Theory of Machines	2	1	0	3	30	70	100
6	PC	23APC0309	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5	30	70	100
7	PC	23APC0310	Manufacturing processes Lab	0	0	3	1.5	30	70	100
8	SC	23ASC9901	Soft Skills	0	1	2	2	30	70	100
9	ES	23AES0304	Design Thinking & Innovation	0	1	2	2	30	70	100
10	MC	23AMC9901	Environmental Science	2	0	0	-	30	-	30
Total				12	6	10	21	300	630	930



Year: II

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AHM0301	Industrial Management	2	0	0	2

Course Outcomes:

- CO: 1 Understand the managerial skills and make efficient facilities in an industry to support organizational goals and objectives
- CO: 2 Apply the ergonomics in designing the work place to manage work processes more efficiently
- CO: 3 Analyze the statistical data with relevant methods and tools to improve the quality in manufacturing (eg. ISO 9001) and focus on continuous improvement (eg. Six Sigma)
- CO: 4 Apply the managerial skills to make financial decision, manage financial resources effectively and contribute to organizational success
- CO: 5 Understand the strategic management to manage human capital, employee well-being effectively and apply knowledge of value analysis for creative problem-solving to achieve innovation

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the managerial skills and make efficient facilities in an industry to support organizational goals and objectives		in enterprise	L2
CO2	Apply	the ergonomics in designing the work place to manage work processes more efficiently		In manufacturing organization	L3
CO3	Analyze	Analyze the statistical data with relevant methods and tools to improve the quality in manufacturing (eg. ISO 9001) and focus on continuous improvement (eg. Six Sigma)		in quality inspection	L4
CO4	Apply	the managerial skills to make financial decision, manage financial resources effectively and contribute to organizational success		in manufacturing organization	L3
CO5	Understand	the strategic management to manage human capital, employee well-being effectively and apply knowledge of value analysis for creative problem-solving to achieve innovation		in manufacturing organization	L2

UNIT– I

INTRODUCTION: Definition of industrial engineering (I.E), development, applications, role of an industrial engineer, quantitative tools of IE and productivity measurement. Concepts of management, importance, functions of management, scientific management, Taylor's principles, Fayol's principles of management.

PLANT LAYOUT: Factors governing plant location, types of production layouts, advantages and disadvantages of process layout and product layout, applications, quantitative techniques for optimal design of layouts.

UNIT–II

WORK STUDY: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

UNIT–III

STATISTICAL QUALITY CONTROL: Quality control, Quality assurance and its importance, SQC, attribute sampling inspection with single and double sampling, Control charts–X and R –charts X and S charts

and their applications, simple numerical examples.

TOTAL QUALITY MANAGEMENT: Elements of TQM – Continuous Improvement – zero defect concept, quality circles, implementation, applications, ISO quality systems. Six Sigma– definition, basic concepts.

UNIT- IV

FINANCIAL MANAGEMENT: Scope and nature of financial management, Sources of finance, Management of working capital, estimation of working capital requirements, budget and budgetary control, Capital budgeting – Nature of Investment Decisions– Investment Evaluation criteria-NPV, IRR PI, Payback Period and ARR, numerical problems.

UNIT-V

HUMAN RESOURCE MANAGEMENT: Concept of human resource management, personnel management and industrial relations, functions of personnel management, Job- evaluation, its importance and types, merit rating, quantitative methods, wage incentive plans, and types.

VALUE ANALYSIS: Value engineering, implementation procedure, enterprise resource planning and supply chain management.

Text Books:

1. O. P Khanna, Industrial Engineering and Management, Dhanpat Rai Publications(P)Ltd.
2. Martand Telsang, Industrial Engineering and Production Management, S. Chand & Company Ltd. New Delhi

Reference Books:

1. Bhattacharya DK, Industrial Management, S. Chand, publishers.
2. J.G Monks, Operations Management, 3/e, McGraw Hill Publishers.
3. T.R. Banga, S.C. Sharma, N.K. Agarwal, Industrial Engineering and Management Science, Khanna Publishers.
4. Koontz O'Donnell, Principles of Management, McGraw Hill Publishers.
5. R.C. Gupta, Statistical Quality Control, Khanna Publishers.
6. NVS Raju, Industrial Engineering and Management, Cengage India Private Limited.

Online Learning Sources

- https://onlinecourses.nptel.ac.in/noc21_me15/preview
- https://onlinecourses.nptel.ac.in/noc20_mg43/preview
- <https://www.edx.org/learn/industrial-engineering>
- <https://youtube.com/playlist?list=PL299B5CC87110A6E7&si=TghLCbEobuxjEaXi>
- https://youtube.com/playlist?list=PLbjTnj-t5Gkl0z3OHOGK5RB9mvNYvnImW&si=oaX_5RG69hS3v2ll

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MECHANICAL ENGINEERING (ME)

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1	-	-	-	Understand	L2	PO1 PO3 PO5 PSO1 PSO2	Apply (L3) Develop (L3) Apply (L3) Thumb Rule Thumb Rule	2 2 2 2 2
2	-	-	-	Apply	L3	PO1 PO2 PSO1 PSO2	Apply (L3) Identify (L3) Thumb Rule Thumb Rule	3 3 3 2
3	-	-	-	Analyze	L4	PO1 PO4 PO5 PSO1 PSO2	Apply (L3) Analyse (L4) Apply (L3) Thumb Rule Thumb Rule	3 3 3 3 2
4	-	-	-	Apply	L3	PO1 PO2 PSO1 PSO2	Apply (L3) Identify (L3) Thumb Rule Thumb Rule	3 3 3 2
5	-	-	-	Understand	L2	PO1 PO2 PO4 PSO1 PSO2	Apply (L3) Identify (L3) Interpret (L2) Thumb Rule Thumb Rule	2 2 3 2 2

Justification Statements:

CO1: Understand the managerial skills and make efficient facilities in an industry to support organizational goals and objectives.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is same (lower) level as PO1 verb. Therefore, the correlation is low (2).

PO3 Verb: Develop (L3)

CO1: Action verb is same (lower) level as PO3 verb. Therefore, the correlation is high (2).

PO5 Verb: Apply (L3)

CO1: Action verb is same (lower) level as PO5 verb. Therefore, the correlation is low (2).

CO2: Apply the ergonomics in designing the work place to manage work processes more efficiently.

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO2: Action verb is same level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: Identify (L3)

CO2: Action verb is same level as PO2 verb. Therefore, the correlation is high (3).

CO3: Analyze the statistical data with relevant methods and tools to improve the quality in manufacturing (eg. ISO 9001) and focus on continuous improvement (eg. Six Sigma).

Action Verb: Analyze (L4)

PO1 Verb: Apply (L3)

CO3: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).

PO4 Verb: Analyze (L4)

CO3: Action verb is same level as PO4 verb. Therefore, the correlation is high (3).

PO5 Verb: Apply (L3)

CO3: Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).



CO4: Apply the managerial skills to make financial decision, manage financial resources effectively and contribute to organizational success.

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: Identify (L3)

CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3).

CO5: Understand the strategic management to manage human capital, employee well-being effectively and apply knowledge of value analysis for creative problem-solving to achieve innovation.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO5: Action verb is same (lower) level as PO1 verb. Therefore, the correlation is high (2).

PO2 Verb: Identify (L3)

CO5: Action verb is same (lower) level as as PO4 verb. Therefore, the correlation is high (2).

PO4 Verb: Interpret (L2)

CO5: Action verb is same level as PO4 verb. Therefore, the correlation is high (3).



Year: II

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ABS9914	Complex Variables, Probability and Statistics	2	1	0	3

Course Outcomes:

- CO: 1 Apply the differentiation for complex variable functions.
CO: 2 Evaluate the integrals and power series expansions for complex variable functions
CO: 3 Understand the concepts of Probability theory and random variables
CO: 4 Apply various probability distributions to calculate their statistical constants.
CO: 5 Analyze the techniques for testing of hypothesis for large samples

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Apply	the differentiation	for complex variable functions		L3
2	Evaluate	the integrals and power series expansions	for complex variable functions		L5
3	Understand	the concepts of Probability theory and random variables			L2
4	Apply	Various probability distributions	to calculate their statistical constants		L3
5	Analyze	the techniques for testing of hypothesis	for large samples.		L4

UNIT I : Complex Variable – Differentiation

9 Hrs

Introduction to functions of complex variable-concept of Limit, continuity & Differentiation, Cauchy-Riemann equations(Cartesian and polar coordinates), analytic functions, harmonic functions, finding harmonic conjugate-construction of analytic function by Milne Thomson method.

UNIT II: Complex Variable – Integration

10 Hrs

Line integral-Contour integration, Cauchy's integral theorem(Simple Case), Cauchy Integral formula, Power series expansions: Taylor's series, zeros of analytic functions, singularities, Laurent's series, Residues, Cauchy Residue theorem (without proof), Evaluation of integrals of the type.

$$(a) \int_0^{2\pi} (\cos\theta, \sin\theta) d\theta \quad (b) \int_{-\infty}^{\infty} e^{imx} dx$$

UNIT III: Probability theory & Random variables

9Hrs

Probability, probability axioms, addition law and multiplicative law of probability, conditional probability, Baye's theorem, random variables (discrete and continuous), probability density functions, properties, mathematical expectation

UNIT IV: Probability Distributions

9Hrs

Probability distributions - Binomial, Poisson approximation to the binomial distribution, Normal distribution and their properties

UNIT V: Estimation and Testing of hypothesis, large sample tests

9Hrs

Estimation-parameters, statistics, sampling distribution, point estimation, Formulation of null hypothesis, alternative hypothesis, the critical and acceptance regions, level of significance, two types of errors and power of the test.

Large Sample Tests: Test for single proportion, difference of proportions, test for single mean and difference of means. Confidence interval for parameters in one sample and two sample problems



Textbooks:

1. B.S.Grewal, Higher Engineering Mathematics, Khanna Publishers, 2017, 44th Edition
2. Miller and Freund, Probability and Statistics for Engineers, 7/e, Pearson, 2008.
3. R.K.Jain and S.R.K.Iyengar, Advanced Engineering Mathematics, Alpha Science International Ltd., 2021 5th Edition (9th reprint).

Reference Books:

1. B.V.Ramana, Higher Engineering Mathematics, McGraw Hill publishers
3. W. Feller, an Introduction to Probability Theory and its Applications, 1/e, Wiley, 1968.
2. S.Chand, Probability and Statistics by Dr.T.K.V.Iyengar, Dr.B.Krishna Gandhi, S.Ranganatham, Dr.M.V.S.S.N.Prasad.

Online Learning Resources:

1. https://onlinecourses.nptel.ac.in/noc20_ma50/preview
2. <https://archive.nptel.ac.in/courses/111/106/111106111/>

Mapping of COs to POs

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
1	3										
2		3									
3	2										
4	3										
5		3									

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Action Verb	BTL			
1				Apply	L3	PO1	Apply(L3)	3
2				Evaluate	L5	PO2	Analyze (L4)	3
3				Understand	L2	PO1	Apply(L3)	2
4				Apply	L3	PO1	Apply (L3)	3
5				Analyze	L4	PO2	Analyze (L4)	3

CO1: Apply the differentiation for complex variable functions.

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO1 Action Verb is equal to PO1 verb; Therefore correlation is high (3).

CO2: Evaluate the integrals and power series expansions for complex variable functions

Action Verb: Evaluate (L5)

PO2 Verb: Analyze (L4)

CO2 Action Verb is high level to PO2 verb; Therefore correlation is high (3).

CO3: Understand the concepts of Probability theory and random variables .

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO3 Action Verb is less than PO1 verb by one level; Therefore correlation is moderate(2).

CO4: Apply various probability distributions to calculate their statistical constants.

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO4 Action Verb level is equal to PO1 verb; Therefore correlation is high (3).



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CO5: Analyze the techniques for testing of hypothesis for large samples.

Action Verb: Analyze(L4)

PO2 Verb: Analyze (L4)

CO5 Action verb is same level to PO2 verb; therefore the correlation is high (3).



Year: II

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0306	Manufacturing processes	2	1	0	3

Course Outcomes:

- CO: 1 Analyze the steps involved in fabrication of metal products
- CO: 2 Understand the classification of welding methods used for joining metals
- CO: 3 Apply the different categories of bulk forming techniques for fabrication of metals
- CO: 4 Analyze the various sheet metal forming and high-energy rate forming processes for fabrication of metals
- CO: 5 Analyze the different types of additive manufacturing processes for production of components

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the steps involved in fabrication of metal products			L4
CO2	Analyze	the classification of welding methods used		for joining metals	L4
CO3	Apply	the different categories of bulk forming techniques		for fabrication of metals	L3
CO4	Analyze	the various sheet metal forming and high-energy rate forming processes		for fabrication of metals	L4
CO5	Analyze	the different types of additive manufacturing processes		for production of components	L4

Unit I:

Casting: Steps involved in making a casting – Advantage of casting and its applications. Patterns and Pattern making – Types of patterns – Materials used for patterns, pattern allowances and their construction, Molding, different types of cores, Principles of Gating, Risers, casting design considerations. Methods of melting and types of furnaces, Solidification of castings and casting defects- causes and remedies. Basic principles and applications of special casting processes - Centrifugal casting, Die casting, Investment casting and shell molding.

Unit II

Welding: Classification of welding processes, types of welded joints and their characteristics, Gas welding, Different types of flames and uses, Oxy – Acetylene Gas cutting. Basic principles of Arc welding, power characteristics, Manual metal arc welding, submerged arc welding, TIG & MIG welding. Electro-slag welding. Resistance welding, Friction welding, Friction stir welding, Forge welding, Explosive welding; Thermit welding, Plasma Arc welding, Laser welding, electron beam welding, Soldering & Brazing. Heat affected zones in welding; pre & post heating, welding defects – causes and remedies.

Unit III

Bulk Forming: Plastic deformation in metals and alloys-recovery, recrystallization and grain growth. Hot working and Cold Working-Strain hardening and Annealing. Bulk forming processes: Forging-Types of Forging, forging defects and remedies; Rolling – fundamentals, types of rolling mills and products, Forces in rolling and power requirements. Extrusion and its characteristics. Types of extrusion, Impact extrusion, Hydrostatic extrusion; Wire drawing and Tube drawing.

Unit IV



Sheetmetal forming-Blanking and piercing, Forces and power requirement in these operations, Deep drawing, stretch forming, Bending, Spring back and its remedies, Coining, Spinning, Types of presses and press tools. High energy rate forming processes: Principles of explosive forming, electromagnetic forming, Electro hydraulic forming, rubber pad forming, advantages and limitations.

Unit V

Additive manufacturing - Steps in Additive Manufacturing (AM), Classification of AM processes, Advantages of AM, and types of materials for AM, VAT photopolymerization AM Processes, Extrusion - Based AM Processes, Powder Bed Fusion AM Processes, Direct Energy Deposition AM Processes, Post Processing of AM Parts, Applications.

Text Books:

1. Kalpak Jain S and Steven R Schmid, Manufacturing Processes for Engineering Materials, 5/e, Pearson Publications, 2007.
2. P.N. Rao, Manufacturing Technology -Vol I, 5/e, McGraw Hill Education, 2018

Reference Books:

1. A. Ghosh & A.K. Malik, Manufacturing Science, East West Press Pvt. Ltd, 2010.
2. Lindberg and Roy, Processes and materials of manufacture, 4/e, Prentice Hall India Learning Private Limited, 1990.
3. R.K. Jain, Production Technology, Khanna Publishers, 2022.
4. Sharma P.C., A Text book of Production Technology, 8/e, S Chand Publishing, 2014.
5. H.S. Shaun, Manufacturing Processes, 1/e, Pearson Publishers, 2012.
6. WAJ Chapman, Workshop Technology, 5/e, CBS Publishers & Distributors Pvt. Ltd, 2001.
7. Hindustan Machine Tools, Production Technology, Tata McGraw Hill Publishers, 2017.
8. Ian Gibson, David W Rosen, Brent Stucker., Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, 2/e, Springer, 2015.

Online Learning Resources:

- <https://www.edx.org/learn/manufacturing/massachusetts-institute-of-technology-fundamentals-of-manufacturing-processes>
- https://onlinecourses.nptel.ac.in/noc21_me81/preview
- www.coursera.org/learn/introduction-to-additive-manufacturing-processessera
- <https://archive.nptel.ac.in/courses/112/103/112103263/>
- <https://elearn.nptel.ac.in/shop/nptel/principles-of-metal-forming-technology/?v=c86ee0d9d7ed>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Manufacturing Processes	CO1	3	3	3		3							3	3
	CO2	3	3	3		3							3	3
	CO3	3	3	3		3							3	3
	CO4	3	3	3		3							3	3
	CO5	3		3		3							3	3



Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	13	20.3	L3	Analyze	L4	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Apply (L3)	3 3 3 3
2	13	20.3	L3	Analyze	L4	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Apply (L3)	3 3 3 3
3	13	20.3	L3	Apply	L3	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Apply (L3)	3 3 3 3
4	13	20.3	L3	Analyze	L4	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Apply (L3)	3 3 3 3
5	12	18.8	L2	Analyze	L4	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
Total	64	100						

Justification Statements:

CO1: Analyze the steps involved in fabrication of metal products

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO1 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

CO2: Analyze the classification of welding methods used for joining metals

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO2 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO2 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

CO3: Apply the different categories of bulk forming techniques for fabrication of metals.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**



CO3 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO3 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

CO4: Analyze the various sheet metal forming and high-energy rate forming processes for fabrication of metals

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO4 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

CO5: Analyze the different types of additive manufacturing processes for production of components

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO5 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO5 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)



Year: II

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0307	Fluid Mechanics & Hydraulic Machines	2	1	0	3

Course Outcomes:

- CO: 1 Understand the basic concepts of fluid properties.
- CO: 2 Evaluate the mechanics of fluids in static and dynamic conditions.
- CO: 3 Apply the Boundary layer theory, flow separation and dimensional analysis.
- CO: 4 Evaluate the hydrodynamic forces of jet on vanes in different positions.
- CO: 5 Understand the working Principles and performance evaluation of pump and hydraulic turbines.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the basic concepts of fluid properties			L2
CO2	Evaluate	the mechanics of fluids in static and dynamic conditions			L5
CO3	Apply	the Boundary layer theory, flow separation and dimensional analysis			L3
CO4	Evaluate	the hydrodynamic forces of jet on vanes in different positions			L5
CO5	Understand	the working Principles and performance evaluation of pump and hydraulic turbines			L2

Unit I:

Fluid statics: Dimensions and units: physical properties of fluids - specific gravity, viscosity and its significance, surface tension, capillarity, vapor pressure. Atmospheric, gauge and vacuum pressure, Measurement of pressure – Manometers - Piezometer, U-tube, inverted and differential manometers. Pascal's & hydrostatic laws.

Buoyancy and floatation: Meta center, stability of floating body. Submerged bodies. Calculation of meta center height. Stability analysis and applications.

Unit II

Fluid kinematics: Introduction, flow types. Equation of continuity for one dimensional flow, circulation and vorticity, Stream line, path line and streak lines and stream tube. Stream function and velocity potential function, differences and relation between them. Condition for irrotational flow, flow net, source and sink, double and vortex flow.

Fluid dynamics: surface and body forces –Euler's and Bernoulli's equations for flow along a streamline, momentum equation and its applications, force on pipe bend

Closed conduit flow: Reynold's experiment- Darcy Weisbach equation- Minor losses in pipes- pipes in series and pipes in parallel-total energy line-hydraulic gradient line.

Unit III

Boundary Layer Theory: Introduction, momentum integral equation, displacement, momentum and energy thickness, separation of boundary layer, control of flow separation, Stream lined body, Bluff body and its applications, basic concepts of velocity profiles.

Dimensional Analysis: Dimensions and Units, Dimensional Homogeneity, Non dimensionalization of equations
Method of repeating variables and Buckingham Pi Theorem.

Unit IV

Basics of turbo machinery: hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, workdone a defficiency, flow Over radial vanes.

Hydraulic Turbines: classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies, hydraulic design – draft tube-theory-functions and efficiency.

Unit V

Performance of hydraulic turbines: Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. Hydraulic systems- hydraulic ram, hydraulic lift, hydraulic coupling. Fluidics – amplifiers, sensors and oscillators. Advantages, limitations and applications.

Centrifugal pumps: classification, working, work done – manometric head- losses and efficiencies-specific speed-pumps in series and parallel-performance characteristic curves, cavitation & NPSH. Reciprocating pumps: Working, Discharge, slip, indicator diagrams.

Text Books:

1. Y.A. Cengel, J.M. Cimbala, Fluid Mechanics, Fundamentals and Applications, 6/e, McGraw Hill Publications, 2019.
2. 2. Dixon, Fluid Mechanics and Thermodynamics of Turbomachinery, 7/e, Elsevier Publishers, 2014

Reference Books:

1. P N Modi and S M Seth, Hydraulics & Fluid Mechanics including Hydraulics Machines, Standard Book House, 2017.
2. RK Bansal, Fluid Mechanics and Hydraulic Machines, 10/e, Laxmi Publications(P)Ltd, 2019.
3. Rajput, Fluid Mechanics and Hydraulic Machines, S Chand & Company, 2016.
4. D.S. Kumar, Fluid Mechanics and Fluid Power Engineering, S K Kataria & Sons, 2013.
5. D. Rama Durgaiah, Fluid Mechanics and Machinery, 1/e, New Age International, 2002

Online Learning Resources:

- <https://archive.nptel.ac.in/courses/112/105/112105206/>
- <https://archive.nptel.ac.in/courses/112/104/112104118/>
- <https://www.edx.org/learn/fluid-mechanics>
- https://onlinecourses.nptel.ac.in/noc20_ce30/previewnptel.ac.in
- www.coursera.org/learn/fluid-powerera

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Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	15	20	2	Understand	L2	PO1 PO2 PO3	APPLY-L3 IDENTIY-L3 DESIGN-L3	2 2 2
2	17	23	3	Evaluate	L5	PO1 PO2 PO3	APPLY-L3 IDENTIY-L3 DESIGN-L3	3 3 3
3	13	18	2	Apply	L3	PO1 PO2 PO3	APPLY-L3 IDENTIY-L3 DESIGN-L3	3 3 3
4	16	22	3	Evaluate	L5	PO1 PO2 PO3	APPLY-L3 IDENTIY-L3 DESIGN-L3	3 3 3
5	13	18	2	Understand	L2	PO1 PO2 PO3	APPLY-L3 IDENTIY-L3 DESIGN-L3	2 2 2

Justification Statements:

CO1: Understand the basic concepts of fluid properties.

ActionVerb: Understand (L2)

PO1Verb: Apply (L3)

CO1 Action verb is less than level as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: Identify (L3)

CO1 Action verb is less than level as PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: Design (L3)

CO1 Action verb is less than level as PO3 verb. Therefore, the correlation is medium (2)

CO2: Evaluate the mechanics of fluids in static and dynamic conditions.

Action Verb: Evaluate (L5)

PO1Verb: Apply (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Design (L3)

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Apply the Boundary layer theory, flow separation and dimensional analysis.

ActionVerb: Apply (L3)

PO1Verb: Apply (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Design (L3)

CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)



Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

CO4: Evaluate the hydrodynamic forces of jet on vanes in different positions.

ActionVerb: Evaluate (L5)

PO1Verb: Apply (L3)

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Design (L3)

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Understand the working Principles and performance evaluation of pump and hydraulic turbines.

ActionVerb: Understand (L2)

PO1Verb: Apply (L3)

CO5 Action verb is less than level as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: Identify (L3)

CO5 Action verb is less than level as PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: Design (L3)

CO5 Action verb is less than level as PO3 verb. Therefore, the correlation is medium (2)



Year: II

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0308	Theory of Machines	2	1	0	3

Course Outcomes:

- CO: 1 Analyze different mechanisms, inversions of different kinematic chains and mobility of mechanisms.
- CO: 2 Evaluate velocity and acceleration of different links in a mechanism.
- CO: 3 Analyze the effects of gyroscopic couple on moving vehicles and the phenomenon of interference in gears.
- CO: 4 Analyze the balancing masses for rotating members and cam profiles for different motions of the follower.
- CO: 5 Evaluate the natural frequencies of mechanical systems based on governing equations and the turning moment diagrams for IC engines.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	different mechanisms, inversions of different kinematic chains and mobility of mechanisms			L4
CO2	Evaluate	velocity and acceleration of different links in a mechanism			L5
CO3	Analyze	the effects of gyroscopic couple on moving vehicles and the phenomenon of interference in gears			L4
CO4	Analyze	the balancing masses for rotating members and cam profiles for different motions of the follower			L4
CO5	Evaluate	the natural frequencies of mechanical systems based on governing equations and the turning moment diagrams for IC engines			L5

Unit I:

Simple Mechanisms: Classification of mechanisms – Basic kinematic concepts and definitions – Degree of freedom, mobility – Grashof's law, kinematic inversions of four bar chain and slider crank chains- Limit positions – Mechanical advantage- Transmission angle- Description of some common mechanisms- Quick return mechanism, straight line mechanisms – Universal Joint – Rocker mechanisms.

Unit II

Plane and motion analysis: Displacement, velocity and acceleration analysis of simple mechanisms, graphical velocity analysis using instantaneous centers, velocity and acceleration analysis using loop closure equations – kinematic analysis of simple mechanisms – slider crank mechanism dynamics – Coincident points – Coriolis component of acceleration.

Unit III

Gyroscope: Principle of gyroscope, gyroscopic effect in an aeroplane, ship, car and two-wheeler, simple problems.

Gear Profile: Involute and cycloidal gear profiles, gear parameters, fundamental law of gearing and conjugate action, spur gear contact ratio and interference/undercutting – helical, bevel, worm, rack & pinion gears, epicyclic and regular gear train kinematics.

Unit IV

Balancing of Rotating masses: Need for balancing, balancing of single mass and several masses in different planes, using analytical and graphical methods.

Cams: Classification of cams and followers- Terminology and definitions – Displacement diagrams –Uniform velocity, parabolic, simple harmonic and cycloidal motions – derivatives of follower motions- specified contour cams- circular and tangent cams –pressure angle and undercutting.

Unit V

Vibrations & Turning Moment Diagrams and Flywheels

Vibrations: Introduction, degree of freedom, types of vibrations, free natural vibrations, Newton method and energy method for single degree of freedom. Damped vibrations- under damped, critically damped; and over damped systems, forced vibrations with and without damping in single degree of freedom; Vibration isolation and transmissibility.

Turning Moment Diagrams and Flywheels: Turning moment diagrams for steam engine, I.C engine and Multi Cylinder Engine. Crank effort – coefficient of fluctuation of energy, coefficient of fluctuation of speed – Fly Wheel and their design, fly wheels for punching press.

Text Books:

1. S.S. Rattan, Theory of Machines, 4/e, Tata Mc-Graw Hill, 2014.
2. P.L. Ballaney, Theory of Machines & Mechanisms, 25/e, Khanna Publishers, Delhi, 2003

Reference Books:

1. F. Haider, Dynamics of Machines, 5/e, Nirali Prakashan, Pune, 2003.
2. J.E. Shigley, Theory of Machines and Mechanisms, 4/e, Oxford, 2014.
3. G.K. Groover, Mechanical Vibrations, 8/e, Nemchand Bros, 2009.
4. Norton, R.L., Design of Machinery – An Introduction to Synthesis and Analysis of Mechanisms and Machines, 2/e, McGraw Hill, New York, 2000.
5. William T. Thomson, Theory of vibration with applications, 4/e, Englewood Cliffs, N.J.: Prentice Hall, 1993

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ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

AK23 Regulations

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	14	17	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
2	16	19.5	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	16	19.5	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
4	18	22	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	18	22	3	Evaluate	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
	82	100						

Justification Statements:

CO1: Analyze different mechanisms, inversions of different kinematic chains and mobility of mechanisms.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO2: Evaluate velocity and acceleration of different links in a mechanism.

Action Verb: Evaluate (L5)

PO1Verb: Apply (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)



PO3 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze the effects of gyroscopic couple on moving vehicles and the phenomenon of interference in gears.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the balancing masses for rotating members and cam profiles for different motions of the follower.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Evaluate the natural frequencies of mechanical systems based on governing equations and the turning moment diagrams for IC engines.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)



Year: II

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0309	Fluid Mechanics & Hydraulic Machines Lab	0	0	3	1.5

Course Outcomes:

- CO: 1 Apply the forces exerted by jet on vanes to measure discharge.
- CO: 2 Evaluate the performance of centrifugal pump, reciprocating pump, Pelton wheel, Francis's turbine, Kaplan turbine etc.
- CO: 3 Analyze the venturi-meter and orifice-meter to measure the discharge of flowing fluid.
- CO: 4 Evaluate frictional losses in pipes with various diameters and Correction factor for given turbine meter
- CO: 5 Apply the concepts of major and minor loss in pipes to measure coefficient of loss of head.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the forces exerted by jet on vanes to measure discharge.			L3
CO2	Evaluate	the performance of centrifugal pump, reciprocating pump, Pelton wheel, Francis turbine, Kaplan turbine etc.			L5
CO3	Analyze	the venturi-meter and orifice-meter to measure the discharge of flowing fluid.			L4
CO4	Evalute	frictional losses in pipes with various diameters and Correction factor for given turbine meter			L5
CO5	Apply	the concepts of major and minor loss in pipes to measure coefficient of loss of head.			L3

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orificemeter.
10. Determination of friction factor for a given pipe line.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Turbine flow meter



Virtual Lab:

1. To study different patterns of a flow through a pipe and correlate them with the Reynolds number of the flow. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/reynolds/introduction.html>)
2. To calculate Total Energy at different points of venture meter. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/bernoulli/introduction.html>).
3. To calculate the flow (or point) velocity at center of the given tube using different flow rates. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/pitot/introduction.html>)
4. To determine the hydrostatic force on a plane surface under partial submerge and full submerge condition. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/cop/introduction.html>).
5. To determine the discharge coefficient of a triangular notch. (<https://me.iitp.ac.in/Virtual-Fluid-Laboratory/notch/introduction.html>)
6. To determine the coefficient of impact of jet on vanes. (<https://fm-nitk.vlabs.ac.in/exp/impact-of-jet>).
7. To determine friction in pipes. (<https://fm-nitk.vlabs.ac.in/exp/friction-in-pipes/index.html>).

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Fluid Mechanics & Hydraulic Machines Lab	CO1	3	2	2						2			2	2
	CO2	3	2	2						2			2	2
	CO3	3	2	2						2			2	2
	CO4	3	2	2						2			2	2
	CO5	3	2	2						2			2	2

CO	Verb	BTL	Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
1	Apply	L3	PO1	Apply-L3	3
			PO2	Identify-L3	3
			PO3	Develop-L3	3
			PO9	Thumb Rule	3
2	Evaluate	L5	PO1	Apply-L3	3
			PO2	Identify-L3	3
			PO3	Develop-L3	3
			PO9	Thumb Rule	3
3	Analyze	L4	PO1	Apply-L3	3
			PO2	Identify-L3	3
			PO3	Develop-L3	3
			PO9	Thumb Rule	3
4	Evaluate	L5	PO1	Apply-L3	3
			PO2	Identify-L3	3
			PO3	Develop-L3	3
			PO9	Thumb Rule	3
5	Apply	L3	PO1	Apply-L3	3
			PO2	Identify-L3	3
			PO3	Develop-L3	3
			PO9	Thumb Rule	3



Justification Statements:

CO1: Apply the forces exerted by jet on vanes to measure discharge . ActionVerb: Apply (L3)
PO1Verb: Apply (L3)

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop(L3)

CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO1 Action verb is same level as PO9 verb. Therefore, the correlation is high(3)

CO2: Evaluate the performance of centrifugal pump, reciprocating pump, Pelton wheel, Francis turbine, Kaplan turbine etc.

Action Verb: Evaluate (L5)

PO1Verb: Apply (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop(L3)

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO2 Action verb is same level as PO9 verb. Therefore, the correlation is high(3)

CO3: Analyze the venturi-meter and orifice-meter to measure the discharge of flowing fluid.

ActionVerb: Analyze (L4)

PO1Verb: Apply (L3)

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop(L3)

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO3 Action verb is same level as PO9 verb. Therefore, the correlation is high(3)

CO4: Evaluate frictional losses in pipes with various diameters and Correction factor for given turbine meter

ActionVerb: Evaluate (L5)

PO1Verb: Apply (L3)

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop(L3)

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO4 Action verb is same level as PO9 verb. Therefore, the correlation is high(3)

CO5: Apply the concepts of major and minor loss in pipes to measure coefficient of loss of head.



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ActionVerb: Apply (L3)

PO1Verb: Apply (L3)

CO5 Action verb is same as level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO5 Action verb is same as level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop(L3)

CO5 Action verb is same as level as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO Action verb is same level as PO9 verb. Therefore, the correlation is high(3)



Year: II

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0310	Manufacturing Processes Lab	0	0	3	1.5

Course Outcomes:

- CO: 1 Analyze the patter making, mould and sand properties for sand casting.
CO: 2 Apply the different welding techniques for joining of metal components
CO: 3 Apply the blow and injection moulding techniques for fabrication of different types of components.
CO: 4 Apply the sheet metal, deep drawing and extrusion operations for fabrication of metals.
CO: 5 Apply the 3D-Printing techniques for manufacturing various components

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the patter making, mould and sand properties		for sand casting.	L4
CO2	Apply	the different welding techniques		for joining of metal components	L3
CO3	Apply	the blow and injection moulding techniques		for fabrication of different types of components.	L3
CO4	Apply	the sheet metal, deep drawing and extrusion operations		for fabrication of metals.	L3
CO5	Apply	the 3D-Printing techniques		for manufacturing various components.	L3

List of Experiments:

- Design and making of pattern
 - Single piece pattern
 - Split pattern
- Sand properties testing
 - Sieve analysis (dry sand)
 - Clay content test
 - Moisture content test
 - Strength test (Compression test & Shear test)
 - Permeability test
- Mould preparation
 - Straight pipe
 - Bent pipe



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- iii. Dumble
- iv. Gear blank
- 4. Gas cutting and welding
- 5. Manual metal arc welding
 - i. Lap joint
 - ii. Butt joint
- 6. Injection Moulding
- 7. Blow Moulding
- 8. Simple models using sheet metal operations
- 9. Study of deep drawing and extrusion operations
- 10. To make weldments using TIG/MIG welding
- 11. To weld using Spot welding machine
- 12. To join using Brazing and Soldering
- 13. To make simple parts on a 3D printing machine
- 14. Demonstration of metal casting

Virtual Lab:

1. To study and observe various stages of casting through demonstration of casting process. (<https://virtual-labs.github.io/exp-sand-casting-process-dei/theory.html>)
2. To weld and cut metals using an oxyacetylene welding setup. (<https://virtual-labs.github.io/exp-gas-cutting-processes-iitkgp/index.html>).
3. To simulate Fused deposition modelling process (FDM) (<https://3dpdei.vlabs.ac.in/exp/simulation-modelling-process>)
4. <https://altair.com/inspire-mold/>
5. <https://virtual-labs.github.io/exp-simulation-cartesian-system-dei/theory.html>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Manufacturing Processes Lab	CO1	3	3	3		3	2			3			3	3
	CO2	3	3	3		3	2			3			3	3
	CO3	3		3		3	2			3			3	3
	CO4	3	3	3		3	1			3			3	3
	CO5	3		3		3	1			3			2	2

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	-	-	-	Analyze	L4	PO1 PO2 PO3 PO5 PO6	Apply (L3) Identify (L3) Develop (L3) Apply (L3) Thumb Rule	3 3 3 3 2



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						PO9	Thumb Rule	3
2	-	-	-	Apply	L3	PO1 PO2 PO3 PO5 PO6 PO9	Apply (L3) Identify (L3) Develop (L3) Apply (L3) Thumb Rule Thumb Rule	3 3 3 3 2 3
3	-	-	-	Apply	L3	PO1 PO3 PO5 PO6 PO9	Apply (L3) Develop (L3) Apply (L3) Thumb Rule Thumb Rule	3 3 3 2 3
4	-	-	-	Apply	L3	PO1 PO2 PO3 PO5 PO6 PO9	Apply (L3) Identify (L3) Develop (L3) Apply (L3) Thumb Rule Thumb Rule	3 3 3 3 1 3
5	-	-	-	Apply	L3	PO1 PO3 PO5 PO6 PO9	Apply (L3) Develop (L3) Apply (L3) Thumb Rule Thumb Rule	3 3 3 1 3

Justification Statements:

CO1: Analyze the patter making, mould and sand properties for sand casting.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO1 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

PO6 and PO9 Verb: **Thumb Rule**

As per thumb rule, CO1 are co-relates moderately and highly with PO6 and PO9, correspondingly. Therefore, the correlation is medium (2) and high (3).

CO2: Apply the different welding techniques for joining of metal components.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO2 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO2 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

PO6 and PO9 Verb: **Thumb Rule**



As per thumb rule, CO1 are co-relates moderately and highly with PO6 and PO9, correspondingly. Therefore, the correlation is medium (2) and high (3).

CO3: Apply the blow and injection moulding techniques for fabrication of different types of components.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO3 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO3 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

PO6 and PO9 Verb: **Thumb Rule**

As per thumb rule, CO1 are co-relates moderately and highly with PO6 and PO9, correspondingly. Therefore, the correlation is medium (2) and high (3).

CO4: Apply the sheet metal, deep drawing and extrusion operations for fabrication of metals.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO4 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

PO6 and PO9 Verb: **Thumb Rule**

As per thumb rule, CO1 are co-relates slightly and highly with PO6 and PO9, correspondingly. Therefore, the correlation is low (1) and high (3).

CO5: Apply the 3D-Printing techniques for manufacturing various components

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO5 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO5 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3)

PO6 and PO9 Verb: **Thumb Rule**

As per thumb rule, CO1 are co-relates slightly and highly with PO6 and PO9, correspondingly. Therefore, the correlation is low (1) and high (3).



Year: II

Semester: II

Branch of Study: Common to all

Subject Code	Subject Name	L	T/CLC	P	Credits
23ASC9901	Soft Skills	0	1	2	2

Course Outcomes:

- CO: 1 Understand the concepts and principles of design thinking process.
- CO: 2 Apply the design thinking techniques for solving problems in various sectors.
- CO: 3 Analyze the art of innovation & creativity in product development.
- CO: 4 Apply the design guidelines for produced development.
- CO: 5 Analyze the design thinking strategies for solving real time business issues.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the various techniques of soft skills and communication skills.			L2
2	Analyze	the listening and thinking skills to enhance professional development.			L4
3	Apply	the critical thinking skills in problem solving and decision making through Discussions .			L3
4	Evaluate	the emotional intelligence and stress management to control in themselves and others.			L5
5	Apply	the corporate etiquette atmosphere to enhance professional behavior in workplace environment.			L3

UNIT I Soft Skills & Communication Skills

Soft Skills - Introduction, Need - Mastering Techniques of Soft Skills – Communication Skills -Significance, process, types - Barriers of communication - Improving techniques.

Activities:

Intrapersonal Skills- Narration about self- strengths and weaknesses- clarity of thought – self- expression – articulating with felicity.

(The facilitator can guide the participants before the activity citing examples from the lives of the great, anecdotes and literary sources)

Interpersonal Skills- Group Discussion – Debate – Team Tasks - Book and film Reviews by groups - Group leader presenting views (non- controversial and secular) on contemporary issues or on a given topic.

Verbal Communication- Oral Presentations- Extempore- brief addresses and speeches- convincing- negotiating- agreeing and disagreeing with professional grace.

Non-verbal communication – Public speaking – Mock interviews – presentations with an objective to identify non- verbal clues and remedy the lapses on observation.

UNIT II Critical Thinking

Active Listening – Observation – Curiosity – Introspection – Analytical Thinking – Open-mindedness – Creative Thinking - Positive thinking - Reflection



Activities:

Gathering information and statistics on a topic - sequencing – assorting – reasoning – critiquing issues – placing the problem – finding the root cause - seeking viable solution – judging with rationale – evaluating the views of others - Case Study, Story Analysis

UNIT III Problem Solving & Decision Making

Meaning & features of Problem Solving – Managing Conflict – Conflict resolution – Team building - Effective decision making in teams – Methods & Styles

Activities:

Placing a problem which involves conflict of interests, choice and views – formulating the problem – exploring solutions by proper reasoning – Discussion on important professional, career and organizational decisions and initiate debate on the appropriateness of the decision.

Case Study & Group Discussion

UNIT IV Emotional Intelligence & Stress Management

Managing Emotions – Thinking before Reacting – Empathy for Others – Self-awareness – Self-Regulation – Stress factors – Controlling Stress – Tips

Activities:

Providing situations for the participants to express emotions such as happiness, enthusiasm, gratitude, sympathy, and confidence, compassion in the form of written or oral presentations.

Providing opportunities for the participants to narrate certain crisis and stress –ridden situations caused by failure, anger, jealousy, resentment and frustration in the form of written and oral presentation, Organizing Debates

UNIT V Corporate Etiquette

Etiquette- Introduction, concept, significance - Corporate etiquette - meaning, modern etiquette, benefits - Global and local culture sensitivity - Gender Sensitivity - Etiquette in interaction- Cell phone etiquette - Dining etiquette - Netiquette - Job interview etiquette -Corporate grooming tips -Overcoming challenges

Activities

Providing situations to take part in the Role Plays where the students will learn about bad and good manners and etiquette - Group Activities to showcase gender sensitivity, dining etiquette etc. - Conducting mock job interviews - Case Study - Business Etiquette Games

Prescribed Books:

1. Mitra Barun K, Personality Development and Soft Skills, Oxford University Press, Pap/Cdr edition 2012
2. Dr Shikha Kapoor, Personality Development and Soft Skills: Preparing for Tomorrow, I K International Publishing House, 2018

Reference Books:

1. Sharma, Prashant, Soft Skills: Personality Development for Life Success, BPB Publications 2018.
2. Alex K, Soft Skills S.Chand & Co, 2012 (Revised edition)
3. Gajendra Singh Chauhan & Sangeetha Sharma, Soft Skills: An Integrated Approach to Maximise Personality Published by Wiley, 2013
4. Pillai, Sabina & Fernandez Agna, Soft Skills and Employability Skills, Cambridge University Press, 2018
5. Soft Skills for a Big Impact (English, Paperback, Renu Shorey) Publisher: Notion Press



6. Dr. Rajiv Kumar Jain, Dr. Usha Jain, Life Skills (Paperback English) Publisher : Vayu Education of India, 2014

Online Learning Resources:

1. https://youtu.be/DUlsNJtg2L8?list=PLLy_2iUCG87CQhELCYtvXh0E_y-bOO1_q
2. https://youtu.be/xBaLgJZ0t6A?list=PLzf4HHlsQFwJZel_j2PUy0pwjVUgj7KlJ
3. <https://youtu.be/-Y-R9hDI7IU>
4. <https://youtu.be/gkLsn4ddmTs>
5. <https://youtu.be/2bf9K2rRWwo>
6. <https://youtu.be/FchfE3c2jzc>
7. <https://www.businesstrainingworks.com/training-resource/five-free-business-etiquette-training-games/>
8. https://onlinecourses.nptel.ac.in/noc24_hs15/preview
9. https://onlinecourses.nptel.ac.in/noc21_hs76/preview

Course Title	Course Outcomes COs	Programme Outcomes (POs)											
		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12
Soft Skills Lab	CO1										2		
	CO2									3	3		
	CO3									2			
	CO4									3			
	CO5									2	2		

CO-PO mapping justification:

C O	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO6 to PO11)	Level of Correlation (0-3)
	(Approx. Hrs)	%	corr	Verb	BTL			
1			CO1	UNDERSTAND	L2	PO10	Thumb rule	2
2			CO2	ANALYZE	L4	PO9, PO10	Thumb rule	3,3
3			CO3	APPLY	L3	PO9	Thumb rule	2
4			CO4	EVALUATE	L5	PO9	Thumb rule	3
5			CO5	Apply	L3	PO9, PO10	Thumb rule	2,2

CO1: Understand the various techniques of soft skills and communication skills.

Action Verb: Understand (L2)

CO1 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).

CO2: Analyze the listening and thinking skills to enhance professional development.

Action Verb: Analyze (L4)

CO2 Action Verb Analyze is of BTL 4. Using Thumb rule, L4 correlates PO6 to PO11 as high (3)

CO3: Apply the critical thinking skills in problem solving and decision making through Discussions .



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Action Verb: Apply (L3)

CO3 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2).

CO4: Evaluate the emotional intelligence and stress management to control themselves and others.

Action Verb: Evaluate (L5)

CO4 Action Verb Evaluate is of BTL 5. Using Thumb rule, L2 correlates PO6 to PO11 as high (3).

CO5: : Apply the corporate etiquette atmosphere to enhance professional behavior in workplace environment.

Action Verb: Create e (L3)

CO5 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2).



Year: II

Semester: II

Branch of Study: Common to all

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0304	Design Thinking & Innovation	0	1	2	2

Course Outcomes:

- CO: 1 Understand the concepts and principles of design thinking process.
- CO: 2 Apply the design thinking techniques for solving problems in various sectors.
- CO: 3 Analyze the art of innovation & creativity in product development.
- CO: 4 Apply the design guidelines for produced development.
- CO: 5 Analyze the design thinking strategies for solving real time business issues.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts and principles of design thinking process.			L1
CO2	Apply	the design thinking techniques for solving problems in various sectors.			L3
CO3	Analyze	the art of innovation & creativity in product development.			L4
CO4	Apply	the design guidelines for produced development.			L3
CO5	Analyze	the design thinking strategies for solving real time business issues.			L4

Unit I:

Introduction to elements and principles of Design, basics of design-dot, line, shape, form as fundamental design components. Principles of design. Introduction to design thinking, history of Design Thinking, New materials in Industry.

Unit II

Design thinking process (empathize, analyze, idea & prototype), implementing the process in driving inventions, design thinking in social innovations. Tools of design thinking - person, costumer, journey map, brainstorming, product development

Activity: Every student presents their idea in three minutes, Every student can present design process in the form of flow diagram or flow chart etc. Every student should explain about product development.

Unit III

Art of innovation, Difference between innovation and creativity, role of creativity and innovation in organizations- Creativity to Innovation- Teams for innovation- Measuring the impact and value of creativity.

Activity: Debate on innovation and creativity, Flow and planning from idea to innovation, Debate on value-based innovation.

Unit IV

Problem formation, introduction to product design, Product strategies, Product value, Product planning, product specifications- Innovation towards product design- Case studies

Activity: Importance of modelling, how to set specifications, Explaining their own product design.



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AK23 Regulations

Unit V

Design Thinking applied in Business & Strategic Innovation, Design Thinking principles that redefine business – Business challenges: Growth, Predictability, Change, Maintaining Relevance, Extreme competition, Standardization. Design thinking to meet corporate needs- Design thinking for Startups- Defining and testing Business Models and Business Cases- Developing & testing prototypes

Activity: How to market our own product, About maintenance, Reliability and plan for startup.

Text Books:

1. Tim Brown, Change by design, Harper Bollins (2009)
2. Idris Mootee, Design Thinking for Strategic Innovation, 2013, John Wiley & Sons.

Reference Books:

1. David Lee, Design Thinking in the Classroom, Ulysses press
2. Shruti N Shetty, Design the Future, Norton Press
3. William Lidwell, Universal Principles of Design- Kritina holden, Jill Butter.
4. Chesbrough. H, The Era of Open Innovation – 2013

Online Learning Resources:

- <https://nptel.ac.in/courses/110/106/110106124/>
- <https://nptel.ac.in/courses/109/104/109104109/>
- https://swayam.gov.in/nd1_noc19_mg60/preview

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts and principles of design thinking process.			L1
CO2	Apply	the design thinking techniques for solving problems in various sectors.			L3
CO3	Analyze	the art of innovation & creativity in product development.			L4
CO4	Apply	the design guidelines for product development.			L3
CO5	Analyze	the design thinking strategies for solving real time business issues.			L4

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Design Thinking & Innovation	CO1	2		2									2	2
	CO2	2	2	2									2	2
	CO3	2	2	2			1						2	2
	CO4	2	2	2			1						2	2
	CO5	2	2	2			2						2	2

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	11	20.3	L3	Understand	L2	PO1 PO3	Apply (L3) Develop (L3)	2 2
2	10	18.5	L2	Apply	L3	PO1 PO2	Apply (L3) Identify (L3)	3 3



						PO3	Develop (L3)	3
3	11	20.3	L3	Analyze	L4	PO1 PO2 PO3 PO6	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 1
4	12	22.2	L3	Apply	L3	PO1 PO2 PO3 PO6	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 1
5	10	18.5	L2	Analyze	L4	PO1 PO2 PO3 PO6	Apply (L3) Identify (L3) Develop (L3) Thumb Rule	3 3 3 2
Total	54	100						

Justification Statements:

CO1: Understand the concepts and principles of design thinking process.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is lower than PO1 verb. Therefore, the correlation is medium (2)

PO3 Verb: **Develop (L3)**

CO1 Action verb is lower than PO3 verb. Therefore, the correlation is medium (2)

CO2: Apply the design thinking techniques for solving problems in various sectors.

PO1 Verb: **Apply (L3)**

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze the art of innovation & creativity in product development.

Action Verb: **Analyze (L4)**

PO1 Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO3 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO4: Apply the design guidelines for produced development.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)



PO6 Verb: Thumb Rule

As per thumb rule CO4 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO5: Analyze the design thinking strategies for solving real time business issues.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is low (1)

PO6 Verb: Thumb Rule

As per thumb rule CO5 co-relates moderately with PO6 verb. Therefore, the correlation is high (3)



Year: II

Semester: II

Branch of Study: AIML & DS

Subject Code	Subject Name	L	T/CLC	P	Credits
23AMC9901	Environmental Studies	2	0	0	0

Course Outcomes:

- CO: 1 Understand the multidisciplinary nature of environmental studies, various renewable and nonrenewable resources.
- CO: 2 Understand the ecosystem and biodiversity to solve complex environmental problems
- CO: 3 Apply the various types of pollution, solid waste management, and related preventive measures
- CO: 4 Apply the rainwater harvesting, watershed management, ozone layer depletion, and wasteland reclamation.
- CO: 5 Analyze the population explosion and impact of environmental health issues on human being.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
1	Understand	the multidisciplinary nature of environmental studies, various renewable and nonrenewable resources.			L2
2	Understand	the ecosystem and biodiversity	to solve complex environmental problems		L2
3	Apply	the various types of pollution, solid waste management, and related preventive measures			L3
4	Apply	the rainwater harvesting, watershed management, ozone layer depletion, and wasteland reclamation			L3
5	Analyze	the population explosion and impact of environmental health issues on human being.			L4

UNIT – I

Multidisciplinary Nature of Environmental Studies: Introduction – Multidisciplinary Nature of Environmental Studies – Definition, Scope and Importance – Need for Public Awareness.

Natural Resources: Renewable and non-renewable energy resources –Natural resources and associated problems.

Forest resources: Use and over – exploitation, deforestation, case studies – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources: Use and overutilization of surface and sub-surface – Floods, drought, conflicts over water, dams – benefits and problems.

Mineral resources: Use and exploitation, environmental effects of extracting and using mineral resources, case studies.

Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticides problems, water logging, salinity, case studies.

Energy resources: Renewable and non-renewable energy resources.



UNIT – II

Ecosystems: Concept of an ecosystem. – Structure and functions of an ecosystem – Producers, consumers and decomposers – Energy flow in the ecosystem – Ecological succession – Food chains, food webs and ecological pyramids – Introduction, types, characteristic features, structure and function of the following ecosystem: Forest ecosystem, Grassland ecosystem, Desert ecosystem and Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries).

Biodiversity And Its Conservation : Introduction- Definition:genetic, species and ecosystem diversity – Value of biodiversity: consumptive use, Productive use, social, ethical, aesthetic and option values – Biodiversity at global, National and local levels – India as a mega-diversity nation – Hot-spots of biodiversity – Threats to biodiversity:

habitat loss, poaching of wildlife, man - wildlife conflicts – Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

UNIT – III

Environmental Pollution: Definition, Causes, effects and its control measures of: Air Pollution, Water pollution, Soil pollution, Marine pollution, Noise pollution, and Thermal pollution and Nuclear hazards.

Solid Waste Management: Causes, effects and control measures of urban and industrial wastes – Role of an individual in prevention of pollution – Pollution case studies – Disaster management: earthquakes, cyclones, tsunamis, and landslides.

UNIT – IV

Social Issues and the Environment: From Unsustainable to Sustainable development – Urban problems related to energy – Water conservation, Rainwater harvesting and Watershed Management – Resettlement and rehabilitation of people – Case studies – Environmental ethics: Issues and possible solutions – Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case Studies– Wasteland reclamation. – Consumerism and waste products. – Environment Protection Act. – Air (Prevention and Control of Pollution) Act. – Water (Prevention and control of Pollution) Act – Wildlife Protection Act – Forest Conservation Act – Public awareness.

UNIT – V

Human Population and the Environment: Population growth, variation among nations. Population explosion – Family Welfare Programs. – Environment and human health – Human Rights – Value Education – HIV/AIDS – Women and Child Welfare – Role of Information Technology in Environment and human health – Case studies..

Textbooks:

1. Textbook of Environmental Studies for Undergraduate Courses Erach Bharucha for University Grants Commission, Universities Press.
2. Palaniswamy, “Environmental Studies”, Pearson education
3. S.Azeem Unnisa, “Environmental Studies” Academic Publishing Company
4. K.Raghavan Nambiar, “Text book of Environmental Studies for Undergraduate Courses as per UGC model syllabus”, Scitech Publications (India), Pvt. Ltd.

References:

1. Deeksha Dave and E.Sai Baba Reddy, “Textbook of Environmental Science”, Cengage Publications.
2. M.Anji Reddy, “Text book of Environmental Sciences and Technology”, BS Publication.
3. J.P.Sharma, Comprehensive Environmental studies, Laxmi publications.
4. J. Glynn Henry and Gary W. Heinke, “Environmental Sciences and Engineering”, Prentice hall of India Private limited
5. G.R.Chatwal, “A Text Book of Environmental Studies” Himalaya Publishing House
6. Gilbert M. Masters and Wendell P. Ela, “Introduction to Environmental Engineering and Science, Prentice hall of India Private limited.



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

AK23 Regulations

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
1						2	2						
2							2						
3						2	2						
4						2	2						
5							2						

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours				CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	
	Register (Hrs)	Lesson Plan (Hrs)	%	corr	Verb	BTL			
1	10	12	23	3	Understand	L2	PO6, PO7	Thumb Rule Thumb Rule	2, 2
2	15	15	28	3	Understand	L2	PO7	Thumb Rule	2
3	8	8	15	2	Apply	L3	PO6 PO7	Thumb Rule Thumb Rule	2, 2
4	9	10	19	2	Apply	L3	PO6, PO7	Thumb Rule Thumb Rule	2, 2
5	8	8	15	2	Analyze	L4	PO7	Thumb Rule	2
	50	53	100						

CO1: Understand the multidisciplinary nature of environmental studies, various renewable and nonrenewable resources.

Action Verb: Understand (L2)

Using Thumb rule, CO1 correlates PO6 and PO7 as a moderate (2)

CO2: Understand the ecosystem and biodiversity to solve complex environmental problems

Action Verb: Understand (L2)

Using Thumb rule, CO2 correlates PO7 as a moderate (2)

CO3: Apply the various types of pollution, solid waste management, and related preventive measures

Action Verb: APPLY (L3)

Using Thumb rule, CO3 correlates PO6 and PO7 as a moderate (2)

CO4: Apply the rainwater harvesting, watershed management, ozone layer depletion, and wasteland reclamation.

Action Verb: APPLY (L3)

Using Thumb rule, CO4 correlates PO6 and PO7 as a moderate (2)

CO5: Analyze the population explosion and impact of environmental health issues on human being

Action Verb: Analyze (L4)

Using Thumb rule, CO5 correlates PO7 as a moderate (2)



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)
Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)
B. Tech – III Year I Semester

AK23 Regulations

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	PC	23APC0311	Machining Process	2	1	0	3	30	70	100
2	PC	23APC0312	Thermal Engineering	2	1	0	3	30	70	100
3	PC	23APC0313	Metrology and Measurements	2	1	0	3	30	70	100
4	PE-I	23APE0301	Tool Design	2	1	0	3	30	70	100
		23APE0302	Automobile Engineering							
		23APE0303	Mechanical behaviour of Materials							
		23APE0304	Work study and Ergonomics							
		23APE0305	Nano Technology							
5	OE-I		Open Elective - I	2	1	0	3	25	75	100
6	MC	23AES0504	Introduction to Quantum Technology & Applications	2	1	0	3	30	70	100
7	PC	23APC0314	Thermal Engineering Lab	0	0	3	1.5	30	70	100
8	PC	23APC0315	Dynamics lab	0	0	3	1.5	30	70	100
9	SC	23ASC0301	Skill Enhancement course Machine Tools & Metrology lab	0	1	2	2	30	70	100
10	ES	23AES0404	Tinkering Lab	0	0	2	1	30	70	100
11	PR	23APR0301	Evaluation of Community Service Project	-	-	-	2	100	-	100
Total				12	7	10	26	395	705	1100

Open Elective – I

S.No.	Course Code	Course Name	Offered by the Dept.
1	23AOE0101	Green Buildings	CIVIL
2	23AOE0102	Construction Technology and Management	
3	23AOE0201	Electrical Safety Practices and Standards	EEE
4	23AOE0401	Electronic Circuits	ECE
5	23AOE0501	Java Programming	CSE & Allied/IT
6	23AOE0402	Introduction to Artificial Intelligence	
7	23AOE0503	Quantum Technologies and Applications	
8	23AOE9901	Mathematics for Machine Learning and AI	Mathematics
9	23AOE9906	Materials Characterization Techniques	Physics
10	23AOE9911	Chemistry of Energy Systems	Chemistry
11	23AOE9915	English for Competitive Examinations	Humanities
12	23AOEMB01	Entrepreneurship and New Venture Creation	

Note: 1. A student is permitted to register for Honors or a Minor in IV semester after the results of III Semester are declared and students may be allowed to take maximum two subjects per semester pertaining to their Minor from V Semester onwards.

2. A student shall not be permitted to take courses as Open Electives/Minor/Honors with content substantially equivalent to the courses pursued in the student's primary major.

3. A student is permitted to select a Minor program only if the institution is already offering a Major degree program in that discipline.



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0311	Machining Process	2	1	0	3

Course Outcomes:

- CO: 1 Understand the theory of metal cutting for machining the components.
- CO: 2 Analyze the working of lathe, drilling, boring, shaping and planning machines to perform various operations
- CO: 3 Analyze the working of milling, grinding, lapping, honing and broaching machines for surface finishing of components
- CO: 4 Understand the Electrical Energy Based machining processes, mechanism of metal removal, machine tool selection.
- CO: 5 Understand the Chemical machining process, economic aspects of ECM

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	theory of metal cutting for machining the components			L2
CO2	Analyze	working of lathe, drilling, boring, shaping and planning machines	to perform various operations		L3
CO3	Analyze	working of milling, grinding, lapping, honing and broaching machines	for surface finishing of components		L3
CO4	Understand	Electrical Energy Based machining processes for machining the components			L2
CO5	Understand	Chemical machining process for machining the components			L2

Unit I: Elementary treatment of metal cutting theory – Elements of cutting process – Geometry of single point tool and angles, chip formation and types of chips – built up edge and its effects, chip breakers. Mechanics of orthogonal cutting –Merchant's Force diagram, cutting forces – cutting speeds, feed, depth of cut, heat generation, tool life, coolants, machinability –economics of machining. Cutting Tool materials and cutting fluids –types and characteristics.

Unit II

Engine lathe – Principle of working- specification of lathe – types of lathes – work holders and tool holders – Taper turning, thread cutting operations and attachments for Lathes. Drilling, Boring Machines, Shaping, Slotting and planning machines - Principles of working, specifications, types, Tools and tool holding devices – operations performed, machining time calculation.

Unit III

Milling machine – Principles of working – specifications – classifications of milling machines – methods of indexing, milling cutters - machining operation, Accessories to milling machines. Grinding machine –Theory of grinding – classification– cylindrical and surface grinding machine – Tool and cutter grinding machine – Grinding wheel specification - types of abrasives – bonds, Truing and Dressing of wheels. Lapping, Honing and Broaching machines – comparison of grinding, lapping and honing. Principles of design of Jigs and fixtures and uses, Classification of Jigs & Fixtures – Principles of location and clamping –types.



Unit IV

Mechanical Energy Based Processes: Abrasive Jet Machining, Water Jet Machining, Abrasive Water Jet Machining, Ultra Sonic Machining – Working Principle, Description of Equipment, Process Parameters, Metal Removal Rate, Applications, Advantages and Limitations. Electrical Energy Based Processes: Electric Discharge Machining – Wire cut EDM - Working Principles, Process Parameters, Applications Advantages and Limitations.

Unit V

Chemical and Electro Chemical Energy Based Processes: Chemical Machining and Electro Chemical Machining – Working Principle, Etchants, Maskants, Techniques of Applying - Process Parameters, Electro Chemical Grinding, Electro Chemical Honing, Applications, Advantages and Limitations. Thermal Energy Based Processes: Laser Beam Machining and Drilling, Plasma Arc Machining, Electron Beam Machining – Working Principle, Process Parameters, Applications, Advantages and Limitations.

Text Books:

1. Manufacturing Technology-Kalpakzian- Pearson Seventh edition. (2018)
2. Production Technology by R.K. Jain and S.C. Gupta, Khanna Publishers, 17th edition.
3. Jain V.K., Advanced Machining Processes, 1st Edition, Allied Publishers Pvt. Ltd., New Delhi, 2007.

Reference Books:

1. Pandey P.C and Shan H.S., Modern Machining Processes, 1/e, McGraw Hill, New Delhi, 2007.
2. Benedict G.F., Non-traditional Manufacturing Processes, 1/e, CRC Press, 1987.
3. Production Technology by H.M.T. (Hindustan Machine Tools), TMH, 1st edition, 2001
4. Manufacturing Technology Vol II by P.N. Rao, Tata McGraw Hill, 4th edition, 2013
5. Machine Technology Machine tools and operations by Halmi A Yousuf & Harson, CRC Press Taylor and Francies.
6. Workshop Technology – Vol II, B.S.Raghu Vamshi, Dhanpat Rai & Co, 10th edition, 2013.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Machining Process	CO1	3	2	2		2								
	CO2	3	3				1							
	CO3	3	3			3								
	CO4	3	3			2								
	CO5	3	3			2								

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	12	18	2	Understand	L2	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Create (L6) Create(L6)	2 2 2 2
2	12	18	2	Analyze	L3	PO1 PO2 PO6	Apply (L3) Identify (L3) Apply (L3)	3 3 3
3	14	21	3	Analyze	L3	PO1 PO2 PO5	Apply (L3) Identify (L3) Create(L6)	3 3 3
4	16	24	3	Understand	L2	PO1 PO2	Apply (L3) Identify (L3)	3 3



						PO5	Create(L6)	3
5	13	20	2	Understand	L2	PO1 PO2 PO5	Apply (L3) Identify (L3) Create(L6)	3 3 3

Justification Statements:

CO1: Understand the theory of metal cutting for machining the components.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Creating (L6)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Creating (L6)**

CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO2: Analyze the principles of metal cutting and apply them to cutting tool design. Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO6 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO6 verb. Therefore, the correlation is high (3)

CO3: Creating various jigs and fixtures using proper locating and clamping principles.

Action Verb: **Creating (L6)**

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Creating (L6)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO4: Evaluate and design different types of press tool dies for sheet metal operations.

Action Verb: **Evaluate (L5)**

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Creating (L6)**

CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO5: Creating tooling and fixture strategies suitable for CNC machining systems.

Action Verb: **Creating (L6)**

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Creating (L6)**

CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3)



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0312	Thermal Engineering	2	1	0	3

Course Outcomes:

- CO: 1 Understand the engine, SI and CI Engine
- CO: 2 Analyze fuel supply, cooling and ignition system petrol and diesel engines
- CO: 3 Analyze combustion system in SI and CI engine
- CO: 4 Evaluate the performance of IC engine
- CO: 5 Evaluate the performance of the different compressor

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	Definition of Engine and Heat Engine, I.C Engine Classification			L2
CO2	Analyze	Supply System, cooling and ignition of IC engines			L4
CO3	Analyze	Stages of Combustion in SI and CI engines			L4
CO4	Evaluate	Testing and performance of IC engine			L5
CO5	Evaluate	Types of compressors and its performance			L5

Unit I:

I.C. ENGINES: Definition of Engine and Heat Engine, I.C Engine Classification – Parts of I.C. Engines, Working of I.C. Engines, Two Stroke & Four Stroke I.C. Engines SI & CI Engines, Valve and Port Timing Diagrams.

Unit II

Fuel System: S.I. Engine: Fuel Supply Systems, carburetor types Air Filters, Mechanical and Electrical Fuel Pump – Filters– Gasoline Injection Systems.

Cooling & Lubrication Systems: Cooling Requirements, Air Cooling, Liquid Cooling, Thermo Siphon, Water and Forced Circulation System, Lubrication Systems-Flash, Pressurized and Mist Lubrication. Ignition System: Function of an Ignition System, Battery coil Ignition System, Magneto Coil Ignition System, Electronic Ignition System using Contact Breaker, Electronic Ignition using Contact Triggers – Spark Advance and Retard Mechanism.

Unit III

Fuels and Combustion: S I engine: Normal Combustion and Abnormal Combustion – Importance of Flame Speed and Effect of Engine Variables – Type of Abnormal Combustion, Pre-Ignition and Knocking (Explanation) – Fuel Requirements and Fuel Rating, Anti Knock Additives, Combustion Chambers.

Engines: Stages Of Combustion – Delay Period and Its Importance – Effect of Engine Variables – Diesel Knock– Combustion Chambers (DI And IDI), Fuel Requirements and Fuel Rating

Unit IV

Testing and Performance: Parameters of Performance - Measurement of Cylinder Pressure, Fuel Consumption, Air Intake, Exhaust Gas Composition, Brake Power – Determination of Frictional Losses and Indicated Power – Performance Test – Heat Balance Sheet and Chart.



Unit V

Air Compressors: Reciprocating Compressors, Effect of Clearance volume in Compressors, Volumetric Efficiency, Single Stage and Multi Stage Compressors, Effect of Inter cooling and Pressure Drop in Multi - Stage Compressors, Problems Related to Reciprocating Compressors, Working principles of Roots blower, Vane type Blower, Centrifugal Compressor - Axial Flow Compressors.

Text Books:

1. I.C. Engines / V. Ganesan- TMH fourth edition (2017)
2. Thermal Engineering / Rajput / Lakshmi Publications 11th edition (2020)
3. Internal Combustion Engine Fundamentals John B. Heywood TMH (2017)

Reference Books:

1. IC Engines – Mathur& Sharma – DhanpathRai& Sons (2017)
2. Engineering fundamentals of IC Engines – Pulkrabek, Pearson, PHI 2nd edition (2015)
3. Thermal Engineering, Rudramoorthy – TMH First edition (2017)
4. Thermodynamics & Heat Engines, B. Yadav, Central Book Depot., Allahabad (2002)
5. Thermal Engineering / Rajput / Lakshmi Publications 11th edition (2020).

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Thermal Engineering	CO1	2	3	2										
	CO2	3	3	3										
	CO3	3	3	3										
	CO4	3	3	3										
	CO5	3	3	2										

Correlation Matrix

CO				CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18/83	22	2	Understand	L2	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	2 3 2
2	14/83	17	3	Analyze	L3	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	3 3 3
3	27/83	32	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	3 3 3
4	19/83	23	3	Evaluate	L4	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	3 3 3
5	18/93	22	3	Evaluate	L2	PO1 PO2 PO3	Apply (L3) Review (L2) Develop (L3)	2 3 2

Justification Statements:

CO1: Understand the working of S.I and C.I engine

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than as PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Review (L2)

CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO1 Action verb is less than level as PO3 verb. Therefore, the correlation is medium (2)



CO2: Apply the fuel and cooling system for I.C engine

Action Verb: Apply (L3) PO1 Verb: Apply (L3)

CO1 Action verb is as same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Review (L2)

CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO1 Action verb is as same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze the normal and abnormal combustion system as well as fuel rating system

Action Verb: Analyse (L4)

PO1 Verb: Apply (L3)

CO1 Action verb is as same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Review (L2)

CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO1 Action verb is as same level as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the testing performance of I.C engines

Action Verb: Analyse (L4)

PO1 Verb: Apply (L3)

CO1 Action verb is as same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Review (L2)

CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO1 Action verb is as same level as PO3 verb. Therefore, the correlation is high (3)

CO5: Understand the working of air compressor.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than as PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Review (L2)

CO1 Action verb is as same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO1 Action verb is less than level as PO3 verb. Therefore, the correlation is medium (2)



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0313	Metrology and Measurements	2	1	0	3

Course Outcomes:

- CO: 1 Understand the concept of different types of dimensional tolerances and chose the desire limits and fit component to solve the required fit.
- CO: 2 Understand the basic standards of measurements and also apply the desired flatness and surface gauges to analyze the dimensions.
- CO: 3 Analyze engineering parts with various precision instruments and choose the required surface roughness instrument to compare the parts.
- CO: 4 Apply various measuring techniques for Displacement and Strain. Define the various instruments for measuring the displacement and calibrate the strain.
- CO: 5 Understand the Instruments accuracy and Perform calibration of Force, Torque and pressure measuring instruments.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concept of different types of dimensional tolerances and chose the desire limits and fit component to solve the required fit.		in Assembly	L2
CO2	Understand	the basic standards of measurements and also apply the desired flatness and surface gauges to analyze the dimensions.		in quality engineering	L2
CO3	Analyze	engineering parts with various precision instruments and choose the required surface roughness instrument to compare the parts.		in quality and inspection	L4
CO4	Apply	various measuring techniques for Displacement and Strain. Define the various instruments for measuring the displacement and calibrate the strain.		in Instrument Manufacturing	L3
CO5	Understand	the Instruments accuracy and Perform calibration of Force, Torque and pressure measuring instruments.		in precision Engineering	L2

Unit I: Concept of Measurement

Concept of Measurement: Concept of feedback Control systems -generalized measurement system, units and standards, measuring instruments, sensitivity, readability, range of accuracy, precision, static and dynamic response, repeatability, systematic and random errors, correction, calibration, terminology and limits fits and tolerances, hole basis and shaft basis system, interchangeability.

Limit Gauges And Gauge Design: Plug, Ring, Snap, Gap, Taper gauges. Taylor's principle. Design of Go and No Go gauges.

Linear and Angular Measurement: Linear measuring instruments: Vernier instruments, micrometers, slip gauges, tool makers microscope. Comparators: Mechanical, pneumatic and electrical. Angular measurements: Sine bar, bevel protractor and angle dekkor, rollers and spheres used to determine the tapers.

Unit II

Flatness and Surface Roughness measurement

Flatness Measurement: Measurement of flatness – straight edges – surface plates, optical flat and autocollimators, interferometers and their applications.

Surface Roughness Measurement: Terminology systems, differences between surface roughness and surface waviness- Numerical assessment of surface finish - CLA, R.M.S Value-Ra , Rz values, Methods of measurement of surface finish-profilograph, talysurf, BIS symbols for indication of surface roughness.



Unit III

Screw Thread and Gear Measurement

Screw thread measurements: Elements of threads, errors in screw threads, various methods for measuring external and internal screw threads, screw thread gauges.

Gear Measurement: Gear tooth terminology, measurement of gear elements-run out, lead, pitch backlash, profile, pressure angle, tooth thickness, diameter of gear, constant chord and base tangent method.

Coordinate Measuring Machine (CMM)- Construction and features.

Unit IV

Measurement of Displacement and Strain

Measurement of Displacement: Theory and construction of various transducers to measure displacement – Piezo-electric, inductive, capacitance, resistance, ionization and photoelectric transducers, calibration procedures.

Measurements of Strain: Various types of electrical strain gauges, gauge factor, method of usage of resistance strain gauge for bending, compressive and tensile strains, usage for measuring torque, strain gauge rosettes.

Unit V

Measurement of Force, Torque and Pressure

Measurement of Force: Direct method - analytical balance, platform balance; elastic members – load cells, cantilever beams and proving rings.

Measurement of Torque: Torsion bar dynamometer, servo-controlled dynamometer and absorption dynamometer.

Measurement of Pressure: Standards and calibration, basic methods of pressure measurement, dead weight gauges and manometers, High and low-pressure measurement, Elastic transducers.

Text Books:

1. Beckwith, Marangoni, Linehard, Mechanical Measurements, 6/e, PHI, 2013.
2. N R.K. Jain, Engineering Metrology, 20/e, Khanna Publishers, 2013.

Reference Books:

1. Mahajan, Engineering Metrology, 2/e, Dhanpat Rai, 2013.
2. S.Bhaskar, Basic Principles - Measurements and Control Systems, Anuradha Publications, 2014.
3. Anand K Bewoor & Vinay A Kulkarni, Metrology & Measurement, 15/e, McGrawHill, 2015.
4. D.S. Kumar, Mechanical Measurements & Control, Metropolitan Publishers, 5/e, 2015.

Online Learning Resources:

- https://nitsri.ac.in/Department/Mechanical%20Engineering/MEC_405_Book_2_for_Unit_2_B.pdf
- <https://www.digimat.in/nptel/courses/video/112104250/L47.html>
- <https://www.digimat.in/nptel/courses/video/112106138/L01.html>
- <https://www.digimat.in/nptel/courses/video/112106179/L01.html>
- <https://www.youtube.com/watch?v=tczyyM4Dykc>
- https://www.youtube.com/watch?v=UsAiZ_mRC1M
- https://www.youtube.com/watch?v=oCkax_I19X8

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Metrology and Measurements	CO1	2		2	1									
	CO2	2		2		2								
	CO3	3	3	3										
	CO4	3	3			3								
	CO5	2	2			2								



Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Understand	L2	PO1 PO4 PO3	Apply (L3) Design (L6) Develop (L3)	2 1 2
2				Understand	L2	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	2 2 2
3				Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
4				Apply	L3	PO1 PO2 PO5	Apply (L3) Identify (L3) Apply (L3)	3 3 3
5				Understand	L2	PO1 PO2 PO5	Apply (L3) Identify (L3) Apply (L3)	2 2 2

Justification Statements:

CO1: Understand the concept of different types of dimensional tolerances and chose the desire limits and fit component to solve the required fit.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same (lower) level as PO1 verb. Therefore, the correlation is low (2).

PO4 Verb: **Design (L6)**

CO1 Action verb is same (lower) level as PO4 verb. Therefore, the correlation is low (1).

PO3 Verb: **Develop (L3)**

CO1: Action verb is same (lower) level as PO1 verb. Therefore, the correlation is low (2).

CO2: Understand the basic standards of measurements and also apply the desired flatness and surface gauges to analyze the dimensions.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO2: Action verb is same (lower) level as PO1 verb. Therefore, the correlation is low (2).

PO3 Verb: **Develop (L3)**

CO2: Action verb is same (lower) level as PO3 verb. Therefore, the correlation is low (2).

PO5 Verb: **Apply (L3)**

CO2: Action verb is same (lower) level as PO5 verb. Therefore, the correlation is low (2).

CO3: Analyze engineering parts with various precision instruments and choose the required surface roughness instrument to compare the parts.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4: Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

CO4: Apply various measuring techniques for Displacement and Strain. Define the various instruments for measuring the displacement and calibrate the strain.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3).

PO5 Verb: **Apply (L3)**



CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

CO5: Understand the Instruments accuracy and Perform calibration of Force, Torque and pressure measuring instruments.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO5: Action verb is same (lower) level as PO1 verb. Therefore, the correlation is low (2).

PO2 Verb: **Identify (L3)**

CO5: Action verb is same (lower) level as PO2 verb. Therefore, the correlation is low (2).

PO5 Verb: **Apply (L3)**

CO5: Action verb is same (lower) level as PO5 verb. Therefore, the correlation is low (2).



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0301	Tool Design	2	1	0	3

Course Outcomes:

- CO: 1 Understand the fundamentals of tool engineering and the role of tool design in manufacturing.
- CO: 2 Analyze the principles of metal cutting and apply them to cutting tool design.
- CO: 3 Create various jigs and fixtures using proper locating and clamping principles.
- CO: 4 Evaluate the design considerations of different types of press tool dies for sheet metal operations.
- CO: 5 Create tooling and fixture strategies suitable for CNC machining systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	fundamentals of tool engineering		manufacturing	L2
CO2	Analyze	principles of metal cutting	cutting tool design		L4
CO3	Creating	various jigs and fixtures	proper locating and clamping		L6
CO4	Evaluate	design considerations of different types of press tool dies	sheet metal		L5
CO5	Creating	tooling and fixture strategies	CNC machining		L6

Unit I:

INTRODUCTION TO TOOL DESIGN

Introduction –Tool Engineering – Tool Classifications– Tool Design Objectives – Tool Design in manufacturing- Challenges and requirements- Standards in tool design-Tool drawings -Surface finish – Fits and Tolerances - Tooling Materials- Ferrous and Nonferrous Tooling Materials- Carbides, Ceramics and Diamond -Nonmetallic tool materials-Designing with relation to heat treatment.

Unit II

DESIGN OF CUTTING TOOLS

Mechanics of Metal cutting –Oblique and orthogonal cutting- Chip formation and shear angle - Single-point cutting tools – Milling cutters – Hole making cutting tools- Broaching Tools - Design of Form relieved and profile relieved cutters-Design of gear and thread milling cutters.

Unit III

DESIGN OF JIGS AND FIXTURES

Introduction – Fixed Gauges – Gauge Tolerances –selection of material for Gauges – Indicating Gages – Automatic gages – Principles of location – Locating methods and devices – Principles of clamping – Drill jigs – General considerations in the design of drill jigs – Drill bushings – Methods of construction –Types of Fixtures – Vice Fixtures – Milling Fixtures – Boring Fixtures – Broaching Fixtures.

Unit IV

DESIGN OF PRESS TOOL DIES

Types of Dies –Method of Die operation–Clearance and cutting force calculations- Blanking and Piercing die design – Pilots – Strippers and pressure pads- Presswork materials – Centre of pressure -Strip layout – Short run tooling for Piercing – Bending dies – Drawing dies-Design and drafting.



Unit V

TOOL DESIGN FOR CNC MACHINE TOOLS

Introduction –Tooling requirements for Numerical control systems – Fixture design for CNC machine tools- Sub plate and tombstone fixtures-Universal fixtures– Cutting tools– Tool holding methods– Automatic tool changers and tool positioners – Tool presetting– General explanation of the Brown and Sharp machine.

Text Books:

1. Cyril Donaldson, George H. LeCain, V.C. Goold, —Tool Design, Tata McGraw Hill Publishing Company Ltd., 2000.
2. E.G. Hoffman, Jig and Fixture Design, Thomson Asia Pvt Ltd, Singapore, 2004.

Reference Books:

1. P.C. Sharma, A Text book of Production Engineering, S. Chand Publications, 1999.
2. Prakash Hiralal Joshi, —Tooling data, Wheeler Publishing, 2000
3. Venkataraman K., —Design of Jigs, Fixtures and Press tools, TMH, 2005.
4. Haslehurst M., —Manufacturing Technology, The ELBS, 1978.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Tool Design	CO1	3					2							
	CO2	3	3											
	CO3	2	3	1										
	CO4	2	2	2										
	CO5	3	3	2			1							

Correlation Matrix

CO				CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18	23	3	Understand	2	PO1 PO6	Apply (L3) Develop (L3)	2 3
2	15	19	2	Analyze	4	PO1 PO2	Apply (L3) Identify (L3)	3 3
3	15	19	2	Design	6	PO1 PO2 PO3	Apply (L3) Identify (L3) Design (L6)	3 3 3
4	15	19	2	Evaluate	5	PO1 PO2 PO3	Apply (L3) Identify (L3) Design (L6)	3 3 3
5	16	21	3	Develop	6	PO1 PO2 PO3 PO6	Apply (L3) Identify (L3) Design (L6) Develop (L3)	3 3 3 3

Justification Statements:

CO1: Understand the fundamentals of tool engineering and the role of tool design in manufacturing.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO6 Verb: **Develop (L3)**

CO1 Action verb is same level as PO6 verb. Therefore, the correlation is high (3)

CO2: Analyze the principles of metal cutting and apply them to cutting tool design. Action Verb:



Understand (L2)

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO3: Creating various jigs and fixtures using proper locating and clamping principles.

Action Verb: **Creating (L6)**

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Creating (L6)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO4: Evaluate and design different types of press tool dies for sheet metal operations.

Action Verb: **Evaluate (L5)**

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Creating (L6)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO5: Creating tooling and fixture strategies suitable for CNC machining systems.

Action Verb: **Creating (L6)**

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Creating (L6)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: **Creating (L6)**

CO3: Action verb is same level as PO6 verb. Therefore, the correlation is high (3)



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0302	Automobile Engineering	2	1	0	3

Course Outcomes:

- CO: 1 Analyze the construction and function of major engine components and vehicle structures.
- CO: 2 Design and evaluate ignition and fuel injection systems for various vehicle applications.
- CO: 3 Apply principles of steering and suspension systems to solve vehicle dynamics problems.
- CO: 4 Evaluate and select appropriate wheels, tires, and braking systems for specific vehicle requirements.
- CO: 5 Create and adapt advanced electrical systems and emerging technologies for modern automobiles

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	The construction and function of major engine components and vehicle structures.			L4
CO2	Design	Ignition and fuel injection systems.	for various vehicle applications.		L6
CO3	Apply	Principles of steering and suspension systems.		to solve vehicle dynamics problems.	L3
CO4	Evaluate	And select appropriate wheels, tires, and braking systems.		for specific vehicle requirements.	L5
CO5	Create	And adapt advanced electrical systems and emerging technologies.	for modern automobiles.		L6

Unit I:

Introduction to vehicle structure and engine components

Vehicle construction - Chassis and body - Specifications - Engine - Types - Construction - Location of engine - Cylinder arrangement - Construction details - Cylinder block – Cylinder head - Cylinder liners - Piston – piston rings - Piston pin - Connecting rod - Crankshaft - Valves. Lubrication system - Types – Oil pumps - Filters. Crankcase ventilation.

Unit II

Ignition and fuel supply systems

Ignition system - Coil and Magneto - Spark plug - Distributor – Electronic ignition system - Fuel system - Carburetor - Fuel pumps - Fuel injection systems - Mono point and Multi point – Unit Injector – Nozzle types - Electronic Fuel Injection system (EFI) – GDI, MPFI, DTSI.

Unit III

Steering and suspension system

Principle of steering - Steering Geometry and wheel alignment - Steering linkages – Steering gearboxes - Power steering - front axle - Suspension system - Independent and Solid axle – coil, leaf spring and air suspensions - torsion bar - shock absorbers.



Unit IV

Wheels, Tyres and Braking System

Wheels and Tyres - Construction - Type and specification - Tyre wear and causes - Brakes - Needs – Classification – Drum and Disc Mechanical - Hydraulic and pneumatic – Vacuum assist – Retarders – Anti-lock Braking System (ABS).

Unit V

Automobile electrical systems and advances in automobile engineering

Battery-General electrical circuits- Active Suspension System (ASS) - Electronic Brake Distribution (EBD) – Electronic Stability Program(ESP), Traction Control System (TCS) - Global Positioning System (GPS), Hybrid vehicle, Fuel Cell.

Text Books:

1. Kirpal Singh, Automobile Engineering, Vol.1&2, Standard Publications, 13/e, 2020.
2. William. H. Crouse, Automotive Mechanics, 10/e, McGraw-Hill, 2006.
3. David A. Corolla, Automotive Engineering: Powertrain, Chassis System and Vehicle Body, Butterworth-Heinemann Publishing Ltd, 2009

Reference Books:

1. Bosch, Automotive Hand Book, 6/e, SAE Publications, 2007.
2. K. Newton and W. Steeds, The motor vehicle, 13/e, Butterworth-Heinemann Publishing Ltd, 1989.
3. Joseph Heitner, Automotive Mechanics Principles and Practices, 2/e, CBS publishing 2004.
4. Richard Stone, Jeffrey K. Ball, Automotive Engineering Fundamentals" SAE International, 2004.

Online Learning Resources:

- <https://nptel.ac.in/courses/107106088>
- <https://nptel.ac.in/courses/107106080>
- <https://hindustanuniv.ac.in/assets/pdf/ug/CBCS/cbcs-automobile-2018.pdf>
- https://ed.iitm.ac.in/~shankarram/Course_Files/ED5160/ED5160.htm
- https://dbatu.ac.in/wp-content/uploads/2020/07/B-Tech-Automobile_Final-Yr_22.06.2020-pdf
- <https://www.youtube.com/channel/UCGLlbnSTaLNUPhDwsMe-SgQ>

CO-PO Mapping:

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Automobile Engineering	CO1	3	2	-	-	-	-	-	-	-	-	-	3	2
	CO2	2	3	3	-	-	-	-	-	-	-	-	3	3
	CO3	3	2	-	-	2	-	-	-	-	-	-	2	-
	CO4	2	3	2	-	-	-	-	-	-	-	-	3	2
	CO5	2	3	3	-	3	-	1	-	-	-	-	3	3

Correlation Matrix

CO				CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	9	20	3	Analyze	L4	PO1, PO2	Apply (L3) Analyze (L4)	3
2	9	20	3	Design	L6	PO1, PO2, PO3	Apply (L3) Analyze (L4) Design (L6)	3



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

3	9	20	3	Apply	L3	PO1, PO2, PO5	Apply (L3) Analyze (L4) Usage (L3)	3
4	9	20	3	Evaluate	L5	PO1, PO2, PO3,	Apply (L3) Analyze (L4) Design (L6)	3
5	9	20	3	Create	L6	PO1, PO2, PO3, PO5	Apply (L3) Analyze (L4) Design (L6) Usage (L3)	3

Justification Statements:

CO1: Analyze the construction and function of major engine components and vehicle structures.

Action Verb: Analyze (L4)

PO1 & PO2 Verbs: Apply (L3), Analyze (L4)

The CO1 Action Verb 'Analyze' (L4) is at a higher level than PO1's 'Apply' (L3) and is equal to PO2's 'Analyze' (L4). This outcome requires the identification and analysis of complex engineering problems related to vehicle systems. Therefore, the correlation is high (3).

CO2: Design and evaluate ignition and fuel injection systems for various vehicle applications.

Action Verb: Design (L6)

PO1, PO2, & PO3 Verbs: Apply (L3), Analyze (L4), Design (L6)

The CO2 Action Verb 'Design' (L6) is at a higher cognitive level than PO1 and PO2 and is equal to PO3's 'Design' (L6). This outcome involves designing solutions for complex engineering problems. Therefore, the correlation is high (3).

CO3: Apply principles of steering and suspension systems to solve vehicle dynamics problems.

Action Verb: Apply (L3)

PO1 & PO5 Verbs: Apply (L3), Usage (L3)

The CO3 Action Verb 'Apply' (L3) is at the same cognitive level as the verbs for PO1 and PO5. This outcome directly involves the application of engineering knowledge and modern tools to solve problems. Therefore, the correlation is high (3).

CO4: Evaluate and select appropriate wheels, tires, and braking systems for specific vehicle requirements.

Action Verb: Evaluate (L5)

PO2 & PO3 Verbs: Analyze (L4), Design (L6)

The CO4 Action Verb 'Evaluate' (L5) is a higher-order skill that requires analysis (PO2) and is a critical component of the design process (PO3). The ability to make judgments based on criteria is fundamental to these POs. Therefore, the correlation is high (3).

CO5: Create and adapt advanced electrical systems and emerging technologies for modern automobiles.

Action Verb: Create (L6)

PO3 & PO5 Verbs: Design (L6), Usage (L3)

The CO5 Action Verb 'Create' (L6) is synonymous with 'Design' (PO3) and involves the application of modern engineering tools (PO5) to develop new systems and solutions for sustainable development (PO7). Therefore, the correlation is high (3).



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0303	Mechanical behaviour of Materials	2	1	0	3

Course Outcomes:

- CO: 1 Understand the elastic and plastic behaviour of engineering materials.
- CO: 2 Analyze various strengthening mechanisms in materials.
- CO: 3 Analyze the mechanisms of fracture and apply fracture mechanics principles.
- CO: 4 Evaluate fatigue behavior and apply fracture mechanics in design.
- CO: 5 Analyze creep behavior and high-temperature material response.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the elastic and plastic behaviour of engineering materials			L2
CO2	Analyze	various strengthening mechanisms in materials			L4
CO3	Analyze	the mechanisms of fracture and apply fracture mechanics principles			L4
CO4	Evaluate	fatigue behavior and apply fracture mechanics in design			L5
CO5	Analyze	creep behavior and high-temperature material response			L4

UNIT– I

Elastic and plastic behavior: Elastic behavior of materials – Hooke's law, plastic behavior: dislocation theory – Burger's vectors and dislocation loops, dislocations in FCC, HCP and BCC lattice, stress fields and energies of dislocations, forces on and between dislocations, slip and twinning.

UNIT–II

Strengthening mechanisms: Cold Working, Grain Size Strengthening, Solid Solution Strengthening, Martensitic Strengthening, Precipitation Strengthening, Dispersion Strengthening, Fibre Strengthening, Examples. Yield Point Phenomenon, Strain aging and Dynamic strain aging.

UNIT–III

Fracture and fracture mechanics: Types of Fracture, Basic Mechanism of Ductile and Brittle Fracture, Griffith's Theory of Brittle Fracture, Ductile to Brittle Transition Temperature (DBTT), Factors Affecting DBTT, Determination of DBTT. Fracture Mechanics-Introduction, Modes of Fracture, Stress Intensity Factor, Strain Energy Release Rate, Fracture Toughness and Determination of KIC.

UNIT–IV

Fatigue behaviour and testing: Stress Cycles, S-N Curves, Effect of Mean Stress, Factors Affecting Fatigue, Structural Changes Accompanying Fatigue, Cumulative Damage, HCF / LCF, Thermo-mechanical Fatigue, Application of Fracture Mechanics to Fatigue Crack Propagation-Paris law- Fatigue Testing Machines.

UNIT– V

Creep behavior and testing: Creep Curve, Stages in Creep Curve and Explanation, Structural Changes during Creep, Creep Mechanisms, Metallurgical Factors Affecting Creep, High Temperature Alloys, Stress Rupture Testing, Creep Testing Machines.



Text Books:

1. Dieter, G.E., “Mechanical Metallurgy”, McGraw-Hill, SI Edition, 1995.
2. Davis. H. E., Troxell G.E., Hauck.G. E. W., “The Testing of Engineering Materials”, McGraw-Hill, 1982.

Reference Books:

1. Wulff, The Structure and Properties of Materials, Vol. III “Mechanical Behavior of Materials”, John Wiley and Sons, 1983.
2. Honey Combe R. W. K., “Plastic Deformation of Materials”, Edward Arnold Publishers, 1984.
3. Suryanarayana, A. V. K., “Testing of Metallic Materials”, Prentice Hall India, 1979.

Articulation matrix

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Mechanical Behaviour of Materials	CO1	3	3										3	3
	CO2	3	3										3	3
	CO3	3	3										3	3
	CO4	3	3										3	3
	CO5	3	3										3	3

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	14	18.9	2	Understand	L2	PO1 PO2	Apply (L3) Identify (L3)	2 2
2	14	18.9	2	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
3	16	21.6	3	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	16	21.6	3	Evaluate	L5	PO1 PO2	Apply (L3) Identify (L3)	3 3
5	14	18.9	2	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3

Justification Statements:

CO1: Understand the elastic and plastic behaviour of engineering materials.

Action Verb: Understand (L2)

PO1Verb: Apply (L3)

CO1 Action verb is same level (lesser) as PO1 verb. Therefore, the correlation is moderate (2)

PO2 Verb: Identify (L3)

CO1 Action verb is same level (lesser) as PO1 verb. Therefore, the correlation is moderate (2)

CO2: Analyze various strengthening mechanisms in materials.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)



CO3: Analyze the mechanisms of fracture and apply fracture mechanics principles.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO4: Evaluate fatigue behavior and apply fracture mechanics in design.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO5: Analyze creep behavior and high-temperature material response.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0304	Work study and Ergonomics	2	1	0	3

Course Outcomes:

- CO: 1 Understand the concepts related to principles of productivity & work study as a tool for increasing the efficiency and effectiveness in organizational systems.
- CO: 2 Apply the knowledge of various charts constructing on the basis of present method, compare and propose a new method to identify the unnecessary movements.
- CO: 3 Apply the basis procedure of work measurement techniques and to gain knowledge of measurement of work, rating and imbibe the concept of allowance in estimating Standard Time.
- CO: 4 Analyze and determine the basic ideas of ergonomics and demonstrate a sound knowledge of Ergonomics in engineering applications.
- CO: 5 Evaluate the developed concepts related Man-Machine Interfaces and Design of Displays and controls in engineering systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts related to principles of productivity & work study as a tool for increasing the efficiency and effectiveness in organizational systems.		in industries	L2
CO2	Apply	the knowledge of various charts constructing on the basis of present method, compare and propose a new method to identify the unnecessary movements.		in lean manufacturing	L3
CO3	Apply	the basis procedure of work measurement techniques and to gain knowledge of measurement of work, rating and imbibe the concept of allowance in estimating Standard Time.		in quality and performance improvement	L3
CO4	Analyze	and determine the basic ideas of ergonomics and demonstrate a sound knowledge of Ergonomics in engineering applications.		in mass production	L4
CO5	Evaluate	the developed concepts related Man-Machine Interfaces and Design of Displays and controls in engineering systems.		in automation	L5

Unit I: Productivity and Work Study: Definition of productivity, task of management, productivity of materials, land, building, machine and power, factors affecting the productivity, work content, basic work content, excess work content, how manufacturing job is made up, work content due to excess product and process, ineffective time due to short comings on part of the management. Definition, Objective and scope of Work Study: Work study and management, work study and work.

Unit II

Method Study: Definition, objective and scope of method study, activity recording and tools, Recording tools: Out Line Process Chart, Flow Process Chart, Flow diagram, String Diagram, Travel Chart, Multiple Activity Chart, Two- Handed process chart.

Principles of Motion Economy: Introduction, Classification of movements. Two- hand process chart, Micromotion study, Therbligs, SIMO Chart. Special Charts: Cyclegraph and Chronocycle graph - development, definition and installation of the improved method. Work Measurement: Definition, objectives, work measurement techniques.

Work sampling – Need, confidence levels, and sample size determination, conducting study with problems



Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18	24	3	Understand	L2	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	2 2 2
2	15	20	2	Apply	L3	PO1 PO3 PO5	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	15	20	2	Apply	L3	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Apply (L3)	3 3 3 3
4	15	20	2	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
5	12	16	2	Evaluate	L5	PO1 PO2 PO4	Apply (L3) Identify (L3) Design (L6)	3 3 2

Justification Statements:

CO1: Understand the concepts related to principles of productivity & work study as a tool for increasing the efficiency and effectiveness in organizational systems.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same (lower) level as PO1 verb. Therefore, the correlation is low (2).

PO2 Verb: **Identify (L3)**

CO1 Action verb is same (lower) level as PO2 verb. Therefore, the correlation is low (2).

PO3 Verb: **Develop (L3)**

CO1: Action verb is same (lower) level as PO3 verb. Therefore, the correlation is low (2).

CO2: Apply the knowledge of various charts constructing on the basis of present method, compare and propose a new method to identify the unnecessary movements.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO2: Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO3: Apply the basis procedure of work measurement techniques and to gain knowledge of measurement of work, rating and imbibe the concept of allowance in estimating Standard Time.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: **Develop (L3)**

CO3: Action verb is same level as PO3 verb. Therefore, the correlation is high (3).

PO5 Verb: **Apply (L3)**

CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

CO4: Analyze and determine the basic ideas of ergonomics and demonstrate a sound knowledge of Ergonomics in engineering applications.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**



CO4: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4: Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3)

CO5: Evaluate the developed concepts related Man-Machine Interfaces and Design of Displays and controls in engineering systems.

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO5: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO5: Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).

PO4 Verb: **Design (L6)**

CO5: Action verb is same (lower) level as PO4 verb. Therefore, the correlation is low (2).



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0305	Nano Technology	2	1	0	3

Course Outcomes:

- CO: 1 Understand the nano-science concepts and properties of nano-materials
- CO: 2 Analyze the processing techniques to synthesis and fabricate nano-materials
- CO: 3 Analyze the characterization techniques to study the morphological behaviour of nano-materials
- CO: 4 Analyze the synthesis and characterization techniques of carbon-based materials.
- CO: 5 Apply the nanotechnology concepts to real time applications in various fields

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the nano-science concepts and properties of nano-materials			L2
CO2	Analyze	the processing techniques to synthesis and fabricate nano-materials			L4
CO3	Analyze	the characterization techniques to study the morphological behaviour of nano-materials			L4
CO4	Analyze	the synthesis and characterization techniques	of carbon-based materials		L2
CO5	Apply	the nanotechnology concepts to real time applications in various fields			L3

UNIT-I

INTRODUCTION: History of nano science, definition of nano meter, nano materials, nano technology. Classification of nano materials. Crystal symmetries, crystal directions, crystal planes. Band structure.

PROPERTIES OF MATERIALS: Mechanical properties, electrical properties, dielectric properties, thermal properties, magnetic properties, opto electronic properties. Effect of size reduction on properties, electronic structure of nano materials.

UNIT-II

SYNTHESIS AND FABRICATION: Synthesis of bulk polycrystalline samples, growth of single crystals. Synthesis techniques for preparation of nano particle – Bottom Up Approach – sol gel synthesis, hydro thermal growth, thin film growth, PVD and CVD; Top Down Approach – Ball milling, micro fabrication, lithography. Requirements for realizing semiconductor nano structures, growth techniques for nano structures

UNIT-III

CHARACTERIZATION TECHNIQUES: X-Ray diffraction and Scherrer method, scanning electron microscopy, transmission electron microscopy, scanning probe microscopy, atomic force microscopy, piezoresponse microscopy, X-ray photoelectron spectroscopy, XANES and XAFS, angle resolved photoemission spectroscopy, diffuse reflectance spectra, photoluminescence spectra, Raman spectroscopy

UNIT-IV

CARBON NANO TECHNOLOGY: Characterization of carbon allotropes, synthesis of diamond – nucleation of diamond, growth and morphology. Applications of nano crystalline diamond films, graphene, applications of carbon nano tubes.

UNIT-V

APPLICATIONS OF NANO TECHNOLOGY: Applications in material science, biology and medicine, surface science, energy and environment. Applications of nano structured thin films, applications of quantum dots.



TEXT BOOK:

1. Nano science and nano technology / M.S Ramachandra Rao, Shubra Singh/Wiley publishers.
2. Introduction to Nanotechnology by Risal Singh, Shipra Mital Gupta, Oxford Higher Education, First Publication 2016.

REFERENCE BOOKS:

1. Introduction to Nano Technology /Charles P. Poole, Jr., Frank J.Owens/Wiley publishers.
2. Nanotechnology /Jermy J Ramsden/Elsevier publishers
3. Nano Materials/A.K.Bandyopadhyay/ New Age
4. Nano The Essentials, T.Pradeep, McGrawHill, 2014
5. Nanotechnology the Science of Small / M.A Shah, K.A Shah/Wiley Publisher.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Nano Technology	CO1	2			3		2					2	2	2
	CO2	3		3		3						3	2	2
	CO3	3	3	3	3	3							2	2
	CO4	3		3	3	3		2					2	2
	CO5			3			3					3	2	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Understand	2	PO1 PO4 PO6 PO11	Apply (L3) Interpret (L2) Thumb Rule Thumb Rule	2 3 2 2
2				Analyze	4	PO1 PO3 PO5 PO11	Apply (L3) Develop (L3) Select (L1) Thumb Rule	3 3 3 3
3				Analyze	4	PO1 PO2 PO3 PO4 PO5	Apply (L3) Identify (L3) Develop (L3) Analyze (L4) Thumb Rule	3 3 3 3 3
4				Analyze	4	PO1 PO3 PO4 PO5 PO7	Apply (L3) Develop (L3) Analyze (L4) Select (L1) Thumb Rule	3 3 3 3 2
5				Apply	2	PO3 PO6 PO11	Develop (L3) Thumb Rule Thumb Rule	3 3 3

Justification Statements:

CO1: Understand the nano-science concepts and properties of nano-materials

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).

PO4 Verb: Interpret (L2)



CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3).

PO6 Verb: **Thumb Rule**

CO1 As per the thumb rule, correlation is chosen as medium (2).

PO11 Verb: **Thumb Rule**

CO1 co-related moderately with PO6. Therefore, correlation is chosen as medium (2).

CO2: Analyze the processing techniques to synthesis and fabricate nano-materials

Action Verb: **Analyze (L4)**

PO1 Verb: **Apply (L3)**

CO2 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).

PO3 Verb: **Develop (L3)**

CO2 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).

PO5 Verb: **Select/Apply (L3)**

CO2 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

PO11 Verb: **Thumb Rule**

CO2 co-related moderately with PO12. Therefore, correlation is chosen as medium (2).

CO3: Analyze the characterization techniques to study the morphological behaviour of nano-materials

Action Verb: **Analyze (L4)**

PO1 Verb: **Apply (L3)**

CO3 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO3 Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: **Develop (L3)**

CO3 Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).

PO4 Verb: **Analyze (L4)**

CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3).

PO5 Verb: **Select/Apply (L3)**

CO3 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

CO4: Analyze the synthesis and characterization techniques of carbon-based materials.

Action Verb: **Analyze (L4)**

PO1 Verb: **Apply (L3)**

CO4 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).

PO3 Verb: **Develop (L3)**

CO4 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).

PO4 Verb: **Analyze (L4)**

CO4 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2).

PO5 Verb: **Select/Apply (L3)**

CO4 Action verb is same (greater) level as PO5 verb. Therefore, the correlation is high (3).

CO5: Apply the nanotechnology concepts to real time applications in various fields

Action Verb: **Apply (L3)**

PO3 Verb: **Develop (L3)**

CO5 Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).

PO6 Verb: **Thumb Rule**

CO5 co-related moderately with PO6. Therefore, correlation is chosen as medium (2).

PO11 Verb: **Thumb Rule**

CO5 co-related highly with PO6. Therefore, correlation is chosen as high (3).



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

Course structure for Four Year Regular B.Tech. Degree Program

(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

AK23 Regulations

Year: III

Semester: I

Branch of Study: Common to all

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0504	Introduction to Quantum Technologies and Applications	2	1	0	3

Course Outcomes:

After studying the course, student will be able to

CO1: Understand the transition from classical to quantum physics and quantum states.

CO2: Understand qubits, quantum systems, and their philosophical significance.

CO3: Analyze quantum computer requirements, system fragility, hardware platforms, and software roles.

CO4: Analyze quantum information, communication, computing, and their future potential.

CO5: Apply quantum applications, industry cases, challenges, and opportunities.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the transition from classical		to quantum physics and quantum states.	L2
CO2	Understand	qubits, quantum systems, and their philosophical significance			L2
CO3	Analyze	quantum computer requirements, system fragility, hardware platforms, and software roles.			L4
CO4	Analyze	quantum information, communication, computing, and their future potential.			L4
CO5	Apply	quantum applications, industry cases, challenges, and opportunities.			L3

UNIT - I	Introduction to Quantum Theory and Technologies	9 Hrs
The transition from classical to quantum physics, Fundamental principles explained conceptually: Superposition, Entanglement, Uncertainty Principle, Wave-particle duality, Classical vs Quantum mechanics – theoretical comparison, Quantum states and measurement: nature of observation, Overview of quantum systems: electrons, photons, atoms, The concept of quantization: discrete energy levels, Why quantum? Strategic, scientific, and technological significance, A snapshot of quantum technologies: Computing, Communication, and Sensing, National and global quantum missions: India's Quantum Mission, EU, USA, China		
UNIT - II	Theoretical Structure of Quantum Information Systems	9 Hrs
What is a qubit? Conceptual understanding using spin and polarization, Comparison: classical bits vs quantum bits, Quantum systems: trapped ions, superconducting circuits, photons (non-engineering view), Quantum coherence and decoherence – intuitive explanation, Theoretical concepts: Hilbert spaces, quantum states, operators – only interpreted in abstract, The role of entanglement and non-locality in systems, Quantum information vs classical information: principles and differences, Philosophical implications: randomness, determinism, and observer role		
UNIT - III	Building a Quantum Computer – Theoretical Challenges and Requirements	9 Hrs
What is required to build a quantum computer (conceptual overview)? Fragility of quantum systems: decoherence, noise, and control, Conditions for a functional quantum system: Isolation, Error management, Scalability, Stability, Theoretical barriers: Why maintaining entanglement is difficult, Error correction as a theoretical necessity, Quantum hardware platforms (brief conceptual comparison), Superconducting circuits, trapped ions, Photonics, Vision vs reality: what's working and what remains elusive, The role of quantum software in managing theoretical complexities		
UNIT - IV	Quantum Communication and Computing – Theoretical Perspective	
Quantum vs Classical Information, Basics of Quantum Communication, Quantum Key Distribution (QKD), Role of Entanglement in Communication, The Idea of the Quantum Internet – Secure Global Networking, Introduction to Quantum Computing, Quantum Parallelism (Many States at Once), Classical		



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MECHANICAL ENGINEERING (ME)

AK23 Regulations

vs Quantum Gates, Challenges: Decoherence and Error Correction, Real-World Importance and Future Potential

UNIT – V	Applications, Use Cases, and the Quantum Future	9 Hrs
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Real-world application domains: Healthcare (drug discovery), Material science, Logistics and optimization, Quantum sensing and precision timing, Industrial case studies: IBM, Google, Microsoft, PsiQuantum, Ethical, societal, and policy considerations, Challenges to adoption: cost, skills, standardization, Emerging careers in quantum: roles, skillsets, and preparation pathways, Educational and research landscape – India's opportunity in the global quantum race

Textbooks:

1. Michael A. Nielsen, Isaac L. Chuang, *Quantum Computation and Quantum Information*, Cambridge University Press, 10th Anniversary Edition, 2010.
2. Eleanor Rieffel and Wolfgang Polak, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
3. Chris Bernhardt, *Quantum Computing for Everyone*, MIT Press, 2019.

Reference Books:

1. David McMahon, *Quantum Computing Explained*, Wiley, 2008.
2. Phillip Kaye, Raymond Laflamme, Michele Mosca, *An Introduction to Quantum Computing*, Oxford University Press, 2007.
3. Scott Aaronson, *Quantum Computing Since Democritus*, Cambridge University Press, 2013.
4. **Alastair I.M. Rae**, *Quantum Physics: A Beginner's Guide*, Oneworld Publications, Revised Edition, 2005.
5. **Eleanor G. Rieffel, Wolfgang H. Polak**, *Quantum Computing: A Gentle Introduction*, MIT Press, 2011.
6. **Leonard Susskind, Art Friedman**, *Quantum Mechanics: The Theoretical Minimum*, Basic Books, 2014.
7. **Bruce Rosenblum, Fred Kuttner**, *Quantum Enigma: Physics Encounters Consciousness*, Oxford University Press, 2nd Edition, 2011.
8. **Giuliano Benenti, Giulio Casati, Giuliano Strini**, *Principles of Quantum Computation and Information, Volume I: Basic Concepts*, World Scientific Publishing, 2004.
9. **K.B. Whaley et al.**, *Quantum Technologies and Industrial Applications: European Roadmap and Strategy Document*, Quantum Flagship, European Commission, 2020.
10. **Department of Science & Technology (DST), Government of India**, *National Mission on Quantum Technologies & Applications – Official Reports and Whitepapers*, MeitY/DST Publications, 2020 onward.

Online Learning Resources:

- [IBM Quantum Experience and Qiskit Tutorials](#)
- [Coursera – Quantum Mechanics and Quantum Computation by UC Berkeley](#)
- [edX – The Quantum Internet and Quantum Computers](#)
- [YouTube – Quantum Computing for the Determined by Michael Nielsen](#)
- Qiskit Textbook – IBM Quantum

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	1									3	2	3
CO2	2	1									3	3	2
CO3	3	3									3	3	3
CO4	3	3							3		3	2	
CO5	3	3						3			3		3

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan(Hrs)	%	Correlation	Co's Action verb	BTL			
1	9	20	2	CO1: Understand	L2	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO11: Thumb Rule	2 1 3



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MECHANICAL ENGINEERING (ME)

2	9	20	2	CO2: Understand	L2	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO11: Thumb Rule	2 1 3
3	9	20	2	CO3: Analyze	L4	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO11: Thumb Rule	3 3 3
4	9	20	2	CO4: Analyze	L4	PO1 PO2 PO11	PO1: Apply(L3) PO2: Analyze (L4) PO11: Thumb Rule	3 3 3
5	9	20	2	CO5: Analyze	L4	PO1 PO2 PO11	PO1: Apply(L3) PO2: Apply(L3) PO11: Thumb Rule	3 3 3
	45	100						

Justification Statements:

CO1: Understand the transition from classical to quantum physics and quantum states.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3)

CO1 Action verb is less than one level PO1 verb. Therefore, the correlation is moderate (2)

PO2 Verb: Analyze (L4)

CO1 Action verb is less than two level PO2 verb. Therefore, the correlation is low (1)

PO11: Thumb Rule

Quantum physics demands that we accept probability and discreteness at nature's core. Therefore, the correlation is high (3)

CO2: Understand qubits, quantum systems, and their philosophical significance.

Action Verb: Understand (L2)

PO1: Apply (L3)

CO2 Action verb is less than one level PO1 verb. Therefore, the correlation is moderate (2)

PO2: Analyze (L4)

CO2 Action verb is less than two level PO2 verb. Therefore, the correlation is low (1)

PO11: Thumb Rule

A qubit is a superposed quantum state that enables powerful new ways to store and process information. Therefore, the correlation is high (3)

CO3: Analyze quantum computer requirements, system fragility, hardware platforms, and software roles.

Action Verb: Apply (L3)

PO1: Apply (L3)

CO3 Action verb is same as PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

CO3 Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)

PO11: Thumb Rule

Building a quantum computer requires stable qubits, precise control, error correction, and scalability. Therefore, the correlation is high (3)

CO4: Analyze quantum information, communication, computing, and their future potential.

Action Verb: Analyze (L4)

PO1: Apply (L3)



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MECHANICAL ENGINEERING (ME)

C04 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2: Analyze (L4)

C04 Action verb is same as PO2 verb. Therefore, the correlation is high (3)

PO11: Thumb Rule

Quantum communication and computing leverage superposition, entanglement, and no-cloning to enable secure communication and powerful computation. Therefore, the correlation is high (3)

C05: Analyze quantum applications, industry cases, challenges, and opportunities.

Action Verb: Analyze (L4)

PO1: Apply (L3)

C05 Action verb is same as PO . Therefore, the correlation is high(3)

PO2: Apply(L3)

C05 Action verb is same as PO2 verb. Therefore, the correlation is high (3)

PO11: Thumb Rule

Quantum technologies enable breakthroughs in healthcare, materials, optimization, and security. Therefore, the correlation is high (3)



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0314	Thermal Engineering Lab	0	0	3	1.5

Course Outcomes:

Course Outcomes: After studying the course, student will be able to:

CO1. Analyze the functioning and performance of an 2-stroke and 4 -Stroke engine

CO2. Evaluate the fuel supply, cooling, lubrication, and ignition systems of an IC engine

CO3. Analyze the flame propagation and combustion of S.I and C.I engines and functioning of boilers.

CO4. Evaluate the indicated power, brake power, friction power, and their methods of measurement

CO5. Analyze the volumetric efficiency of multistage reciprocating air compressors.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the functioning and performance	of an 2-stroke and 4 -Stroke engine		L4
CO2	Evaluate	the fuel supply, cooling, lubrication, and ignition systems	of an IC engine		L5
CO3	Analyze	the flame propagation and combustion and functioning of boilers	of S.I and C.I engines		L4
CO4	Evaluate	the indicated power, brake power, friction power, and their methods of measurement			L5
CO5	Analyze	the volumetric efficiency	of multistage reciprocating air compressors		L4

List of Experiments:

- Valve / Port Timing Diagrams of an I.C. Engines
- Performance Test on a 4 -Stroke Diesel Engines
- Performance Test on 2-Stroke Petrol engine
- Evaluation of Engine friction by conducting Morse test on 4-Stroke Multi cylinderEngine
- Retardation and motoring test on 4- stroke engine
- Heat Balance of an I.C. Engine.
- Air/Fuel Ratio and Volumetric Efficiency of an I.C. Engines.
- Performance Test on Variable Compression Ratio Engines, economical speed test.
- Performance Test on Reciprocating Air – Compressor Unit
- Study of Boilers
- Dismantling / Assembly of Engines to identify the parts and their position in anengine.
- Exhaust Emission test on IC Engines

Online Learning Resources:

- <https://www.youtube.com/watch?v=i4SF47hjnQ&list=PL0AQx5JITK3WUCXXkA9Hev3FFLz4sESSg>
- https://www.youtube.com/watch?v=B-rFIdOiNo&list=PLkUEx3IbW7lfdC2ieft_9FH5zAAvUfZAn



Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Thermal Engineering Lab	CO1	3	1	3					3				3	1
	CO2	3	2	3					3				3	1
	CO3	3	1	3					3				3	2
	CO4	3	2	3					3				3	2
	CO5	3	1	3					3				3	1

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	9	25	3	Analyze	L4	PO1	Apply (L3)	3
						PO2	Formulate (L6)	1
						PO3	Develop (L3)	3
						PO8	Thumb Rule	3
2	6	16	2	Evaluate	L5	PO1	Apply (L3)	3
						PO2	Formulate (L6)	2
						PO3	Develop (L3)	3
						PO8	Thumb Rule	3
3	9	25	3	Analyze	L4	PO1	Apply (L3)	3
						PO2	Formulate (L6)	1
						PO3	Develop (L3)	3
						PO8	Thumb Rule	3
4	6	16	2	Evaluate	L5	PO1	Apply (L3)	3
						PO2	Formulate (L6)	2
						PO3	Develop (L3)	3
						PO8	Thumb Rule	3
5	6	16	2	Analyze	L4	PO1	Apply (L3)	3
						PO2	Formulate (L6)	1
						PO3	Develop (L3)	3
						PO8	Thumb Rule	3
Total	36							

Justification Statements:

CO1: Analyze the working of both S.I and C.I engines with the help of indicator diagrams.

Action Verb: **Analyze (L4)**

PO1 Verb: Apply (L3)

CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Formulate (L6)

CO1 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)

PO3 Verb: Develop (L3)

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO8: using thumb rule CO1 correlates highly PO8. Therefore, the correlation is high (3)

CO2: Evaluate the fuel supply systems, cooling, lubrication and ignition systems

Action Verb: Evaluate (L5)

PO1 Verb: Apply (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Formulate (L6)

CO2 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: Develop (L3)



CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO8: using thumb rule CO2 correlates highly PO8. Therefore, the correlation is high (3)

CO3: Analyze the flame propagation inside the cylinder, stages of combustion in S.I and C.I engines.

Action Verb: **Analyze (L4)**

PO1Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Formulate (L6)

CO1 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)

PO3 Verb: Develop (L3)

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO8: using thumb rule CO3 correlates highly PO8. Therefore, the correlation is high (3)

CO4: Evaluate the indicated power, brake power and friction power and their methods of measurement

Action Verb: Evaluate (L5)

PO1Verb: Apply (L3)

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Formulate (L6)

CO4 Action verb is one level lower than PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: Develop (L3)

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO8: using thumb rule CO4 correlates highly PO8. Therefore, the correlation is high (3)

CO5: Analyze the working of reciprocating and rotary air compressors and work done by single and multistage reciprocating air compressors.

Action Verb: **Analyze (L4)**

PO1 Verb: Apply (L3)

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Formulate (L6)

CO1 Action verb is two levels lower than PO2 verb. Therefore, the correlation is low (1)

PO3 Verb: Develop (L3)

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO8: using thumb rule CO5 correlates highly PO8. Therefore, the correlation is high (3).



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0315	Dynamics Lab	0	0	3	1.5

Course Outcomes:

- CO: 1 Analyze the kinematic behavior of various common mechanisms.
CO: 2 Evaluate the dynamic properties of rotating systems and analyze governor performance.
CO: 3 Analyze cam profiles and understand their motion characteristics.
CO: 4 Analyze the torsional vibration characteristics of single and multi-rotor systems.
CO: 5 Apply principles of balancing to rotating and reciprocating masses and analyze the vibration of continuous systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the kinematic behavior of various common mechanisms			L4
CO2	Evaluate	the dynamic properties of rotating systems and analyze governor performance			L5
CO3	Analyze	cam profiles and understand their motion characteristics			L4
CO4	Analyze	the torsional vibration characteristics of single and multi-rotor systems			L4
CO5	Apply	principles of balancing to rotating and reciprocating masses and analyze the vibration of continuous systems			L3

List of Experiments:

1. Kinematics of Four Bar, Slider Crank, Crank Rocker, Double crank, Double rocker, Oscillating cylinder Mechanisms.
2. Determination of Mass moment of inertia of Fly wheel and Axle system.
3. Determination of range sensitivity, effort etc., for Watts, Porter, Proell, and Hartnell Governors.
4. Cams – Cam profile drawing, Motion curves and study of jump phenomenon.
5. Determination of torsional natural frequency of single Rotor systems. Un damped and Damped Natural frequencies.
6. Determination of torsional natural frequency of Double Rotor systems. Un damped and Damped Natural frequencies.
7. Multi degree freedom suspension system – Determination of influence coefficient.
8. Determination of torsional natural frequency of single and Double Rotor systems.- Un damped and Damped Natural frequencies.
9. Balancing of rotating masses.
10. Balancing of reciprocating masses.
11. Determination of natural Frequency and verification of Laws of springs.
12. Forced Vibration of Cantilever beam – Mode shapes and natural frequencies.

Note: Any TEN of the listed experiments are to be conducted. Out of which any TWO Experiments may be conducted in virtual mode.



Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Dynamics Lab	CO1	3	2	2									3	3
	CO2	3	2	2									3	3
	CO3	3	2	2									3	3
	CO4	3	2	2									3	3
	CO5	3	2	2									3	3

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	9	25	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
2	6	16	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	9	25	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
4	6	16	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	6	16	2	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
Total	36							

Justification Statements:

CO1: Analyze the kinematic behavior of various common mechanisms.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO2: Evaluate the dynamic properties of rotating systems and analyze governor performance.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze cam profiles and understand their motion characteristics.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)



PO2 Verb: **Identify (L3)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the torsional vibration characteristics of single and multi-rotor systems.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Apply principles of balancing to rotating and reciprocating masses and analyze the vibration of continuous systems.

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level as PO3 verb. Therefore, the correlation is high (3).



Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ASC0301	Machine Tools & Metrology Lab	0	1	2	2

Course Outcomes:

- CO: 1 Analyze knowledge about the parts of various machine tools and about different shapes of products that can be produced on them.
 CO: 2 Apply the slotting operations to produce internal and external slots on the component.
 CO: 3 Apply the milling operations to produce groove and gear cutting on the specimen
 CO: 4 Evaluate bores, angles and tapers
 CO: 5 Evaluate alignment tests on various machines

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	about the parts of various machine tools to develop simple components on machine tools			L4
CO2	Apply	slotting operations			L3
CO3	Apply	milling operations to produce groove and gear cutting on the specimen			L3
CO4	Evaluate	bores, angles and tapers machine tools			L5
CO5	Evaluate	alignment tests machines tools			L5

List of Experiments:

1. Introduction of general-purpose machines -Lathe, drilling machine, Milling machine, Shaper, Planning machine, Slotting machine, cylindrical grinder, Surface grinder and Tool and cutter grinder.
2. Operations on Lathe machines- Step turning, Knurling, Taper turning, Thread cutting and Drilling
3. Operations on Drilling machine - Drilling, reaming, tapping, rectangular drilling, circumferential drilling
4. Operations on Shaping machine - (i) Round to square (ii) Round to Hexagonal
5. Operations on Slotter - (i) Keyway (T –slot) (ii) Keyway cutting
6. Operations on milling machines - (i) Indexing (ii) Gear manufacturing

METROLOGY LAB

1. Calibration of vernier calipers, micrometers, vernier height gauge and dial gauges.
2. Measurement of bores by internal micrometers and dial bore indicators.
3. Use of gear tooth vernier caliper for tooth thickness inspection and flange micrometer for checking the chordal thickness of spur gear.
4. Machine tool alignment test on the lathe.
5. Machine tool alignment test on drilling machine.
6. Machine tool alignment test on milling machine.
7. Angle and taper measurements with bevel protractor, Sine bar, rollers and balls.
8. Use of spirit level in finding the straightness of a bed and flatness of a surface.
9. Thread inspection with two wire/ three wire method & tool makers microscope.
10. Surface roughness measurement with roughness measuring instrument.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Machine Tools & Metrology lab	CO1	3	3	3						3			3	3
	CO2	3	3	3						3			3	3
	CO3	3	3	3						3			3	3
	CO4	3	3	3						3			3	3
	CO5	3	3	3						3			3	3



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MECHANICAL ENGINEERING (ME)

AK23 Regulations

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	9	25	3	Analyze	L4	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
2	6	16	2	Apply	L3	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
3	9	25	3	Apply	L3	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
4	6	16	2	Evaluate	L5	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
5	6	16	2	Evaluate	L5	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
Total	36							

Justification Statements:

CO1: Analyze knowledge about the parts of various machine tools and about different shapes of products that can be produced on them.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO1 co-relates highly with PO9. Therefore, the correlation is high (3)

CO2: Apply the slotting operations to produce internal and external slots on the component.

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

CO3: Apply the milling operations to produce groove and gear cutting on the specimen

Action Verb: Apply (L3)



PO1Verb: **Apply (L3)**

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO3 co-relates highly with PO9. Therefore, the correlation is high (3)

CO4: **Evaluate** bores, angles and tapers

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO4 co-relates highly with PO9. Therefore, the correlation is high (3)

CO5: **Evaluate** alignment tests on various machines.

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO5 co-relates highly with PO9. Therefore, the correlation is high (3).



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AK23 Regulations

Year: III

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AES0404	Tinkering Lab	0	0	2	1

The aim of tinkering lab for engineering students is to provide a hands-on learning environment where students can explore, experiment, and innovate by building and testing prototypes. These labs are designed to demonstrate practical skills that complement theoretical knowledge.

Course Outcomes: After studying the course, student will be able to

CO1: Develop arduino/ESP32 programming for basic circuits using breadboard/Tinkercad

CO2: Analyze the LDR interfacing circuits with arduino / ESP32 controllers.

CO3: Analyze the control of traffic light circuit, sensor-based servomotor and mobile app-based LED.

CO4: Design a walking robot and rocket using 3-Dimensional (3D) printing Technology.

CO5: Create a prototype for soil moisture monitor and redesign a motor bike using Design Thinking steps.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Develop	Arduino/ESP32 programming for basic circuits	breadboard/Tinkercad		L3
CO2	Analyze	The LDR interfacing circuits	Arduino / ESP32		L4
CO3	Analyze	The control of traffic light circuit, sensor-based servomotor and mobile app-based LED			L4
CO4	Design	A walking robot and rocket	3D Printing Technology		L6
CO5	Create	A prototype for soil moisture monitor and redesign a motor bike	Design Thinking steps		L6

These labs bridge the gap between academia and industry, providing students with the practical experience. Some students may also develop entrepreneurial skills, potentially leading to start-ups or innovation-driven careers. Tinkering labs aim to cultivate the next generation of engineers by giving them the tools, space, and mind-set to experiment, innovate, and solve real-world challenges.

List of experiments:

- 1) Make your own parallel and series circuits using breadboard for any application of your choice. **(CO1)**
- 2) Demonstrate a traffic light circuit using breadboard. **(CO3)**
- 3) Build and demonstrate automatic Street Light using LDR. **(CO2)**
- 4) Simulate the Arduino LED blinking activity in Tinkercad. **(CO1)**
- 5) Build and demonstrate an Arduino LED blinking activity using Arduino IDE. **(CO1)**
- 6) Interfacing IR Sensor and Servo Motor with Arduino. **(CO3)**
- 7) Blink LED using ESP32. **(CO1)**
- 8) LDR Interfacing with ESP32. **(CO2)**
- 9) Control an LED using Mobile App. **(CO3)**
- 10) Design and 3D print a Walking Robot **(CO4)**
- 11) Design and 3D Print a Rocket. **(CO4)**
- 12) Build a live soil moisture monitoring project, and monitor soil moisture levels of a remote place in your computer dashboard. **(CO5)**
- 13) Demonstrate all the steps in design thinking to redesign a motor bike. **(CO5)**



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Students need to refer to the following links:

- 1) <https://aim.gov.in/pdf/equipment-manual-pdf.pdf>
- 2) <https://atl.aim.gov.in/ATL-Equipment-Manual/>
- 3) <https://aim.gov.in/pdf/Level-1.pdf>
- 4) <https://aim.gov.in/pdf/Level-2.pdf>
- 5) <https://aim.gov.in/pdf/Level-3.pdf>

Course Outcomes: The students will be able to experiment, innovate, and solve real-world challenges.

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3				3								
CO2		3	3		1								
CO3			1		1				3	3			
CO4			3	3	3								
CO5		3	3		3	3			3	3	3		

(Levels of Correlation, viz., 1-Low, 2-Moderate, 3 High)

Correlation matrix

Unit No.	Co's Action verb	BTL	Program Outcome (PO)	PO(s) :Action Verb and BTL(for PO1 to PO11)	Level of Correlation BTL (0-3)
1	CO1: Develop	L3	P01 P05	P01: Apply(L3) P05: Select(L1)	3 3
2	CO2: Analyze	L4	P02 P03 P05	P02: Review (L3) P03: Develop(L3) P05: Create (L6)	3 3 1
3	CO3: Analyze	L4	P03 P05 P09 P010	P03: Design (L6) P05: Create(L6) P09: Thumb rule P010: Thumb rule	1 1 3 3
4	CO4: Design	L6	P03 P04 P05	P03: Analyze(L4) P04: Design(L6) P05: Create(L6)	3 3 3
5	CO5: Create	L6	P02 P03 P05 P06 P09 P010 P011	P02: Review(L2) P03: Analyze(L4) P05: Create(L6) P06: Thumb rule P09: Thumb rule P010: Thumb rule P011: Thumb rule	3 3 3 3 3 3 3

Justification Statements:

CO1: Develop Arduino/ESP32 programming for basic circuits using breadboard/Tinkercad

Action Verb: Develop (L3)

P01 Verb: Apply (L3)

CO1 Action verb is equal as P01 verb. Therefore, the correlation is high (3)

P05 Verb: Select (L1)

CO1 Action verb is greater than as P05 verb. Therefore, the correlation is high (3)

CO2: Analyze the LDR interfacing circuits with Arduino / ESP32 controllers.

Action Verb: Analyze (L4)

P02 Verb: Review (L3)



C02 Action verb is greater than P02 verb. Therefore, the correlation is high (3)

P03 Verb: Develop (L3)

C02 Action verb is greater than P03 verb. Therefore, the correlation is high (3)

P05 Verb: Create (L6)

C02 Action verb is lesser than as P05 verb by two levels Therefore, the correlation is low (1)

C03: Analyze the control of traffic light circuit, sensor-based servomotor and mobile app-based LED.

Action Verb: Analyze (L4)

P03 Verb: Design (L6)

C03 Action verb is lesser than P03 verb by two levels. Therefore, the correlation is low (1)

P05 Verb: Create (L6)

C03 Action verb is lesser than P05 verb by two levels Therefore, the correlation is low (1)

P09: Thumb rule

C03 using Thumb rule, correlates with P09 as high (3)

P010: Thumb rule

C03 using Thumb rule, correlates with P010 as high (3)

C04: Design a walking robot and rocket using 3-Dimensional (3D) printing Technology.

Action Verb: Design (L6)

P03 Verb: Analyze (L4)

C04 Action verb is greater than P03 verb. Therefore, the correlation is high (3)

P04 Verb: Design (L6)

C04 Action verb is equal to P04 verb. Therefore, the correlation is high (3)

P05 Verb: Create (L6)

C04 Action verb is equal to as P05 verb. Therefore, the correlation is high (3)

C05: Create a prototype for soil moisture monitor and redesign a motor bike using Design Thinking steps

Action Verb: Create (L6)

P02 Verb: Review (L2)

C05 Action verb is greater than P02 verb. Therefore, the correlation is high (3)

P03 Verb: Analyze (L4)

C05 Action verb is greater than P03 verb. Therefore, the correlation is high (3)

P05 Verb: Create (L6)

C05 Action verb is equal to P05 verb. Therefore, the correlation is high (3)

P06 Verb: Thumb rule

C05 using Thumb rule, correlates with P06 as high (3)

P09: Thumb rule

C05 using Thumb rule, correlates with P09 as high (3)

P010: Thumb rule

C05 using Thumb rule, correlates with P010 as high (3)

P011: Thumb rule

C05 using Thumb rule, correlates with P011 as high (3)



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B. Tech – III Year II Semester

AK23 Regulations

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	PC	23APC0316	Heat Transfer	2	1	0	3	30	70	100
2	PC	23APC0317	CAD/CAM	2	1	0	3	30	70	100
3	PC	23APC0318	Design of Machine Members	2	1	0	3	30	70	100
4	PE-II	23APE0306	Engineering Fracture Mechanics	2	1	0	3	30	70	100
		23APE0307	Introduction of Turbo Machinery							
		23APE0308	Control Systems							
		23APE0309	Operations Research							
		23APE0310	Smart Materials							
5	PE-III	23APE0311	Applications of Computational Fluid dynamics	2	1	0	3	30	70	100
		23APE0312	Industrial Safety							
		23APE0313	Design of Automobile Transmission Systems							
		23APE0314	Mechanics & Manufacturing of Composite Materials							
		23APE0315	Introduction to hybrid and electric vehicles							
6	OE-II		Open Elective-II	2	1	0	3	25	75	100
7	PC	23APC0319	Heat Transfer Lab	0	0	3	1.5	30	70	100
8	PC	23APC0320	CAD/CAM Lab	0	0	3	1.5	30	70	100
9	SC	23A SC0302	Skill oriented course 3D Printing Lab	0	1	2	2	30	70	100
10	MC	23AMC9902	Mandatory non-credit course Technical paper writing and IPR	2	0	0	-	30	-	30
11	SC	23ASC0303	WORKSHOP	-	-	-	-	-	-	-
Total				14	7	08	23	295	635	930
Mandatory Industry Internship of 6-8 weeks duration during summer vacation										

NOTE: Workshop can be conducted either III Year I semester or III Year II semester and the participation certificate with 90% and above attendance on it shall be submitted to department/ exam branch before III Year II semester regular examination notification is released.



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Open Elective – II

S.No.	Course Code	Course Name	Offered by the Dept.
1	23AOE0103	Disaster Management	CIVIL
2	23AOE0104	Sustainability in Engineering Practices	
3	23AOE0202	Renewable Energy Sources	EEE
4	23AOE0402	Digital Electronics	ECE
5	23AOE0504	Operating Systems	CSE & Allied/IT
6	23AOE0505	Machine Learning	
7	23AOE9902	Optimization Techniques	Mathematics
8	23AOE9903	Mathematical Foundation of Quantum Technologies	
9	23AOE9907	Physics of Electronic Materials and Devices	Physics
10	23AOE9912	Chemistry of Polymers and Applications	Chemistry
11	23AOE9916	Academic Writing and Public Speaking	Humanities



Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0316	Heat Transfer	2	1	0	3

Course Outcomes:

- CO: 1 Evaluate heat conduction problems in various systems, including steady and un-steady conditions, using appropriate mathematical models.
- CO: 2 Analyze convective heat transfer in various systems by applying boundary layer theory and empirical correlations.
- CO: 3 Analyze the concepts of heat transfer with phase change and condensation, and solve related heat transfer problems in engineering applications.
- CO: 4 Evaluate heat exchanger configurations, by analysing appropriate methods.
- CO: 5 Apply radiation laws and mass transfer principles and solve problems involving radiative heat exchange.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Evaluate	Generalized heat conduction equation, steady and un-steady conduction, heat conduction through fins of uniform cross section, fin effectiveness and efficiency.			L5
CO2	Analyze	Boundary layer, Forced and free convection phenomena in external and internal flows, numerical problems on it.			L4
CO3	Analyze	Different regimes of boiling, condensation-film wise and drop wise condensation, problems.			L4
CO4	Evaluate	Heat Transfer Types, LMTD and NTU methods.			L5
CO5	Apply	Radiation Laws, shape factor, radiation exchange between surfaces, Radiation shields, simple problems and Conservation laws and constitutive equations, Fick's law of diffusion.			L3

Unit I: Introduction

Basic modes of heat transfer- rate equations- generalized heat conduction equation-various forms - steady state heat conduction solution for plane and composite slabs - cylinders - critical thickness of insulation- heat conduction through fins of uniform cross section- fin effectiveness and efficiency.

Unsteady State Heat Transfer Conduction- Transient heat conduction- lumped system analysis and use of Heisler charts.

Unit II: Convection

Convection: Basic concepts of convection-heat transfer coefficients - types of convection – forced convection and free convection.

Free Convection: development of hydrodynamic and thermal boundary layer along a vertical plate – use of empirical relations for convective heat transfer on plates and cylinders in horizontal and vertical orientation

Forced convection: In external flow-concepts of hydrodynamic and thermal boundary layer- use of empirical correlations for flow over plates and cylinders.Fluid friction – heat transfer analogy, approximate solution to laminar boundary layer equation for external flow.Internal flow – Use of empirical relations for convective heat transfer in horizontal pipe flow-problems.



Unit III: Boiling and Condensation

Different regimes of boiling- nucleate, transition and film boiling – condensation – film wise and drop wise condensation-problems.

Unit IV

Heat Exchangers Types of heat exchangers- parallel flow- counter flow- cross flow heat exchangers- overall heat transfer coefficient- LMTD and NTU methods- fouling in heat exchangers-problems.

Unit V

Radiation: Radiation heat transfer – thermal radiation – laws of radiation - Black and Gray bodies – shape factor-radiation exchange between surfaces - Radiation shields - Greenhouse effect- simple problems.

Mass Transfer: Conservation laws and constitutive equations - Fick's law of diffusion, isothermal equi-mass - Equimolal diffusion- - diffusion of gases and liquids- mass transfer coefficient.

Text Books:

1. P.K. Nag, Heat Transfer, 3/e, Tata McGraw-Hill, 2011.
2. J.P.Holman, Heat Transfer, 9/e, Tata McGraw-Hill, 2008.
3. R.C.Sachdeva, Fundamentals of Engineering Heat & Mass transfer, New Age International Publishers, 2017

Reference Books:

1. F. P. Incropera and D.P. Dewitt, Fundamentals of Heat and Mass Transfer, 6/e, John Wiley, 2007.
2. Cengel. A.Yunus, Heat Transfer- A Practical Approach, 4/e, Tata McGraw-Hill, 2007.
3. S.P. Sukhatme, A Text book of Heat Transfer, Universities Press, 2005.
4. S. C. Arora& S. Domkundwar , A Course in Heat and Mass Transfer, Dhan pat Rai& CO.(P) LTD-Delhi , 2007.
5. C.P. Kothandaraman and S. Subramanyan, Heat and Mass Transfer data book, New Age Publications, 2014.
6. Er.R.K.Rajput, A Text book of Heat & Mass Transfer, S.Chand publishers,1/e,2018.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Heat Transfer	CO1	3	2										1	
	CO2	3	3	2									2	1
	CO3	3	3	2									1	1
	CO4	3	2	1									1	1
	CO5	3	3	1									2	

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	20	22	3	Evaluate	L5	PO1 PO2	Apply (L3) Identify (L3)	3 3
2	20	22	3	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
3	15	16	3	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	15	16	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	20	22	3	Apply	L3	PO1 PO2	Apply (L3) Identify (L3)	3 3



Justification Statements:

CO1: Evaluate heat conduction problems in various systems, including steady and un-steady conditions, using appropriate mathematical models.

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO1 Action verb is greater as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO1 Action verb is greater as PO2 verb. Therefore, the correlation is high (3)

CO2: Analyze convective heat transfer in various systems by applying boundary layer theory and empirical correlations.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO2: Action verb is greater than PO1 verb by one level. Therefore, the correlation is medium (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is greater than PO2 verb by one level. Therefore, the correlation is medium (3)

CO3: Analyze the concepts of heat transfer with phase change and condensation, and solve related heat transfer problems in engineering applications.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO3: Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3: Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

CO4: Evaluate heat exchanger configurations, by analyzing appropriate methods.

Action Verb: Evaluate (L4)

PO1 Verb: **Apply (L3)**

CO4: Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4: Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4: Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

CO5: Apply radiation laws and mass transfer principles and solve problems involving radiative heat exchange.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO5: Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5: Action verb is greater than PO2 verb. Therefore, the correlation is high (3).



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0317	CAD/CAM	2	1	0	3

Course Outcomes:

- CO: 1 Understand the fundamentals of CAD, CAM, CIM, and Graphics technique in manufacturing
- CO: 2 Apply the parametric and geometric representation of curves, surfaces and solids
- CO: 3 Apply the NC, CNC, DNC part programming, and adaptive control for machining the components
- CO: 4 Analyze the manufacturing strategies of group technology, FMS and Quality control methods in industries
- CO: 5 Analyze the various types of Process planning and Production planning in manufacturing industries.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the fundamentals of CAD, CAM, CIM, and Graphics technique		in manufacturing	L2
CO2	Apply	the parametric and geometric representation		of curves, surfaces and solids	L3
CO3	Apply	the NC, CNC, DNC part programming, and adaptive control		for machining the components	L3
CO4	Analyze	the manufacturing strategies of group technology, FMS and Quality control methods		in industries	L4
CO5	Analyze	the various types of Process planning and Production planning		in manufacturing industries	L4

Unit I:

Overview of CAD/CAM: Product cycle, CAD, CAM and CIM. CAD Tools, CAM Tools, Utilization in an Industrial Environment, Evaluation criteria. CAD data structure, Data base management systems.

Computer Graphics: Co-ordinate systems, Graphics package functions, 2D and 3D transformations, clipping, hidden line / surface removal color, shading.

Unit II

Geometric Modeling: Representation techniques, Parametric and non-parametric representation, various construction methods, wire frame modeling, synthetic curves and their representations, surface modeling, synthetics surfaces and their representations. Solid modeling, solid representation, fundamentals, introduction to boundary representations, constructive solid geometry representations

Unit III

Numerical Control: NC, NC Modes, NC Elements, NC Machine tools and their structure, Machining center, types and features. Controls in NC, CNC systems, DNC systems. Adaptive control machining systems, types of adaptive control.

CNC Part Programming: Fundamentals, NC word, NC Nodes, canned cycles, cutter radius compensation, length compensation, computed assisted part programming using APT: Geometry statements, motion statements, post process statements, auxiliary statements, macro statement program for simple components. **Unit IV**

Group Technology & FMS: Part Family, Classification and Coding, advantages & limitations, Group technology machine cells, benefits. FMS: Introduction, components of FMS, material handling systems, Computer control systems, advantages.

Computer Aided Quality Control: Terminology in Quality control, Inspection and testing, Contact inspection



methods - optical and non-optical, integration of CAQC with CAD and CIM.

Unit V

Computer Aided Processes Planning: Retrieval type and Generative type, benefits Machinability data systems, Computer generated time standards.

Computer integrated production planning: Capacity planning, shop floor control, MRP-I, MRP- II, CIMS benefits. Trends in manufacturing systems: Concepts of Reconfigurable manufacturing, Sustainable manufacturing and lean manufacturing

Text Books:

1. Mikell P. Groover, Emory W. Zimmers , CAD/CAM, 5/e, Pearson Prentice Hall of India, Delhi, 2008.
2. Ibrahim Zeid, R.Siva Subramanian, CAD/CAM: Theory and Practice, 2/e, Tata McGraw-Hill, Delhi, 2009

Reference Books:

1. P. N. Rao, CAD/CAM: Principles and applications, 3/e, Tata McGraw-Hill, Delhi, 2017.
2. P. Radhakrishnan, S. Subramanyan & V. Raju, CAD/CAM/CIM, 3/e, New Age International Publishers, 2008.
3. Computer Aided Manufacturing, 3/e, Tien Chien Chang, Pearson, 2008.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAD/CAM	CO1	2	3										3	
	CO2	3		3		3							3	
	CO3	3		3	3	3							3	
	CO4	3		3		3							3	
	CO5	3		3		3							3	

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Understand	L2	PO1 PO2	Apply (L3) Review (L2)	2 3
2				Apply	L3	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
3				Apply	L3	PO1 PO3 PO4 PO5	Apply (L3) Develop (L3) Apply (L3) Apply (L3)	3 3 3 3
4				Analyze	L4	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
5				Analyze	L4	PO1 PO3 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3

Justification Statements:

CO1: Understand the fundamentals of CAD, CAM, CIM, and Graphics technique in manufacturing

Action Verb: Understand (L2)

PO1 Verb: Apply (L3) CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Review (L2) CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

CO2: Apply the parametric and geometric representation of curves, surfaces and solids



Action Verb: Apply (L3)

PO1 Verb: Apply (L3) CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO5 Verb: Apply (L3)

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

CO3: Apply the part programming (NC, CNC, DNC, and adaptive control) for machining the components

Action Verb: Apply (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO3 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO4 Verb: Apply (L3)

CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

PO5 Verb: Apply (L3)

CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO4: Analyze the manufacturing strategies of group technology, FMS and Quality control methods in industries

Action Verb: Analyze (L4)

PO1 Verb: Apply (L3)

CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO4 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: Apply (L3)

CO4 Action verb is greater than PO5 verb. Therefore, the correlation is high (3)

CO5: Analyze the various types of Process planning and Production planning in manufacturing industries.

Action Verb: Analyze (L4)

PO1 Verb: Apply (L3)

CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO5 Action verb is greater than PO3 verb. Therefore, the correlation is high (3)

PO5 Verb: Apply (L3)

CO5 Action verb is greater than PO5 verb. Therefore, the correlation is high (3)



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0318	Design of Machine Members	2	1	0	3

Course Outcomes:

- CO: 1 Apply design principles for components subjected to static and dynamic loads.
- CO: 2 Apply the design procedures for bolted and welded joints with direct and eccentric loadings.
- CO: 3 Analyze the stresses in design of shafts and couplings under different loads.
- CO: 4 Analyze the stresses induced in clutches, brakes and springs.
- CO: 5 Design of bearings and gears subjected to different loads.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	design principles for components		subjected to static and dynamic loads	L3
CO2	Apply	the design procedures	for bolted and welded joints	with direct and eccentric loadings	L3
CO3	Analyze	the stresses in design of shafts and couplings		under different loads	L4
CO4	Analyze	the stresses induced in clutches, brakes and springs			L4
CO5	Design	of bearings and gears		subjected to different loads	L6

UNIT– I

Introduction, Design for Static and Dynamic loads

Mechanical Engineering Design: Design process, general design considerations, Manufacturing considerations in the design, BIS codes, selection of engineering materials.

Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.

Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for infinite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

UNIT–II

Design of Bolted and Welded Joints

Design of Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, gasketed joints and eccentrically loaded bolted joints.

Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion. Eccentrically loaded welded joints.

UNIT–III

Power transmission shafts and Couplings

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.

Couplings: Design of flange and bushed pin couplings, universal coupling.

UNIT–IV

Design of Clutches, Brakes and Springs

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory



and uniform pressure theory.

Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band and block brakes, disc brakes.

Springs: Design of helical compression, tension, torsion and leaf springs.

UNIT– V

Design of Bearings and Gears

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.

Design of Rolling Contact Bearings: Static and dynamic load capacity, Stribeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue.

Design of Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads.

Text Books:

1. R.L. Norton, Machine Design an Integrated approach, 2/e, Pearson Education, 2004.
2. V.B.Bhandari, Design of Machine Elements, 3/e, Tata McGraw Hill, 2010.

Reference Books:

1. R.K. Jain, Machine Design, Khanna Publications, 1978.
2. J.E. Shigley, Mechanical Engineering Design, 2/e, Tata McGraw Hill, 1986.
3. M.F.Spotts and T.E.Shoup, Design of Machine Elements, 3/e, Prentice Hall (Pearson Education), 2013.
4. K. Mahadevan &K.Balaveera Reddy, Design data handbook, CBS Publications, 4/e, 2018.
5. Dr. N. C. Pandya &Dr. C. S. Shah, Machine design, 17/e, Charotar Publishing House Pvt. Ltd, 2009.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Design of Machine Members	CO1	3	3	3									3	3
	CO2	3	3	3									3	3
	CO3	3	3	3									3	3
	CO4	3	3	3									3	3
	CO5	3	3	3									3	3

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18	20.9	3	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
2	16	18.6	2	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	16	18.6	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
4	18	20.9	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
5	18	20.9	3	Design	L6	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3



Justification Statements:

CO1: Apply design principles for components subjected to static and dynamic loads.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO1 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO2: Apply the design procedures for bolted and welded joints with direct and eccentric loadings.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Analyze the stresses in design of shafts and couplings under different loads.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO4: Analyze the stresses induced in clutches, brakes and springs.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO5: Design of bearings and gears subjected to different loads.

Action Verb: Design (L6)

PO1Verb: Apply (L3)

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Develop (L3)

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0306	Engineering Fracture Mechanics	2	1	0	3

Course Outcomes:

- CO: 1 Understand the fundamental concepts of Elastic and Plastic Fracture Mechanics and their applications in analyzing structural failures.
- CO: 2 Apply energy-based criteria to predict crack growth and fracture.
- CO: 3 Analyze advanced elasticity theory to determine stress and displacement fields around cracks.
- CO: 4 Analyze stress intensity factors for various crack geometries and model plastic deformation at crack tips.
- CO: 5 Evaluate fracture toughness and characterize fatigue crack propagation.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the fundamental concepts of Elastic and Plastic Fracture Mechanics and their applications in analyzing structural failures			L2
CO2	Apply	energy-based criteria to predict crack growth and fracture			L3
CO3	Analyze	advanced elasticity theory to determine stress and displacement fields around cracks			L4
CO4	Analyze	stress intensity factors for various crack geometries and model plastic deformation at crack tips			L4
CO5	Evaluate	fracture toughness and characterize fatigue crack propagation			L5

UNIT– I

EFM Course outline and Spectacular Failures, Introduction to LEFM and EPFM, Fatigue Crack Growth Model.

UNIT–II

Crack Growth and Fracture Mechanisms, Griffith TMs Theory of Fracture, Energy Release Rate.

UNIT–III

Review of Theory of Elasticity, Westergaard Solution for Stress and Displacements for Mode I, Relationship between K and G.

UNIT–IV

Introduction to multi parameter stress field for Mode I, Mode II and Mixed Modes, SIF for Various Geometries, Modeling Plastic Deformation, Irwin TMs model, Dugdale Model.

UNIT– V

Fracture Toughness Testing, Paris Law and Sigmoidal curve, Crack Closure, Crack Growth Models, J-Integral, Failure Assessment Diagram, Mixed Mode Fracture, Crack Arrest and Repair Methodologies.



Text Books:

1. Prashant Kumar, Elements of Fracture Mechanics, Tata McGraw Hill, New Delhi, India, 2009.
2. K. R.Y. Simha, Fracture Mechanics for Modern Engineering Design, Universities Press (India) Limited, 2001.

Reference Books:

1. D. Broek, Elementary Engineering Fracture Mechanics, Kluwer Academic Publishers, Dordrecht, 1986.
2. T.L. Anderson, Fracture Mechanics "Fundamentals and Applications, 3rd Edition, Taylor and Francis Group, 2005.
3. K. Ramesh, e-Book on Engineering Fracture Mechanics, IIT Madras, 2007.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Engineering Fracture Mechanics	CO1	3	3										3	3
	CO2	3	3										3	3
	CO3	3	3										3	3
	CO4	3	3										3	3
	CO5	3	3										3	3

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	14	18.9	2	Understand	L2	PO1 PO2	Apply (L3) Identify (L3)	2 2
2	14	18.9	2	Apply	L3	PO1 PO2	Apply (L3) Identify (L3)	3 3
3	16	21.6	3	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	16	21.6	3	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
5	14	18.9	2	Evaluate	L5	PO1 PO2	Apply (L3) Identify (L3)	3 3

Justification Statements:

CO1: Understand the fundamental concepts of Elastic and Plastic Fracture Mechanics and their applications in analyzing structural failures.

Action Verb: Understand (L2)

PO1Verb: Apply (L3)

CO1 Action verb is same level (lesser) as PO1 verb. Therefore, the correlation is moderate (2)

PO2 Verb: Identify (L3)

CO1 Action verb is same level (lesser) as PO1 verb. Therefore, the correlation is moderate (2)

CO2: Apply energy-based criteria to predict crack growth and fracture.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO3: Analyze advanced elasticity theory to determine stress and displacement fields around cracks.



Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO4: Analyze stress intensity factors for various crack geometries and model plastic deformation at crack tips.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO5: Evaluate fracture toughness and characterize fatigue crack propagation.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0307	Introduction of Turbo Machinery	2	1	0	3

Course Outcomes:

- CO: 1 Understand the principles and classifications of turbo machines (axial, radial, and mixed flow) and equations of motion in a rotating frame of reference, including Coriolis and centrifugal forces.
- CO: 2 Analyze gas turbine cycles including Brayton, regenerative, reheat, and inter-cooled configurations and different engine types (turboprop, turbojet, turbofan) and thrust augmentation techniques.
- CO: 3 Apply similarity rules and specific speed concepts to turbo machinery models using tools like the Cordier diagram, and aerodynamic performance of blade cascades through 2D analysis.
- CO: 4 Design axial and centrifugal compressors and pumps using velocity diagrams, h-s charts, and other design methods, considering flow characteristics, tip clearance, slip factor, and losses.
- CO: 5 Analyze axial flow turbines in terms of stage loading, efficiency, blade design, and blade cooling methods and their impact on turbine performance.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The classification and operating principles of axial, radial, and mixed flow machines.			L2
CO2	Analyze	Gas turbine cycles like Brayton, regenerative, reheat, and inter-cooling.			L4
CO3	Apply	Similarity laws and cascade theory for turbomachinery performance prediction.			L3
CO4	Design	Axial and centrifugal compressors and pumps using velocity triangles and h-s diagrams.			L6
CO5	Analyze	Axial flow turbine stages including cooling and reaction analysis and CFD applications in flow and heat transfer in turbo machinery.			L5

Unit I:

Introduction and Classification: Axial flow, radial flow and mixed flow machines, the equations of motion in rotating frame of reference, effects of Coriolis and Centrifugal forces, momentum and energy equation, Euler work and illustrative examples.

Unit II

Gas Turbine Cycle: Brayton Cycle, regenerative cycle, reheat, inter-cooling, turboprop, turbojet and turbofan engine, thrust augmentation and illustrative examples.

Unit III

Similarity Analysis: Similarity rules, specific speed, Cordier diagram and illustrative examples.

Cascade Analysis: Two-dimensional cascade theory, lift and drag, blade efficiency, estimation of loss, compressor and turbine cascade, blade geometry and illustrative examples.

Unit IV

Axial Flow Compressor: Two-dimensional pitch line design and analysis, h-s diagram, degree of reaction, the effect of Mach number, performance and efficiency, three-dimensional flow, tip clearance, losses, compressor performance and illustrative examples.



Centrifugal Pump and Compressor: Theoretical analysis and design, the effect of circulation and Coriolis forces, reversal eddies, slip factor, head and efficiency, diffuser, introduction to the combustion system and illustrative examples.

Unit V

Axial Flow Turbine: Two-dimensional pitch line design, stage loading capacity, degree of reaction, stage efficiency, turbine performance, blade cooling, and illustrative examples.

CFD Applied to Turbomachinery Flows: Governing equations, numerical methods, and test cases illustrating flow and heat transfer related to turbo machines.

Text Books:

1. Fluid Mechanics and Thermodynamics of Turbomachinery, S. L. Dixon and C. A. Hall, Butterworth-Heinemann, Seventh Edition, 2014.
2. Gas Turbine Theory, H. Cohen, GFC Rogers and H.H. Saravanamuttoo, Addison Wesley Longman Limited, 4th Edition, 1996

Reference Books:

1. Fundamentals of Turbomachinery, Venkanna B. K Prentice Hall India Learning Private Limited, 2009.
2. Principles of Turbomachinery, Seppo A. Korpela, 2nd Edition, (2019) John Wiley and Son's, USA.

Online Learning Resources:

1. https://youtube.com/playlist?list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE&si=ts0mwlf6_etWcmKO1i
2. https://youtube.com/playlist?list=PLWCscP8J8VQ4i0BoPCAgP5mXQh9VWmyuS&si=cLz_UxZke5BJV-lUg
3. <https://youtube.com/playlist?list=PLbMVogVj5nJQQp3QLuzbcHrt0XncZZTiE&si=Rzs-PEl9nqP45rKe>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Introduction of Turbo Machinery	CO1	2	2	2									3	
	CO2	3	3	3									3	
	CO3	3			3	3							3	
	CO4	3		3	3								3	
	CO5	3			3	3							3	3

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18	21	3	Understand	L2	PO1, PO2, PO3	Apply (L3) Identify (L3) Develop(L3)	2 2 2
2	14	16	3	Analyze	L4	PO1, PO2, PO3	Apply (L3) Identify (L3) Develop(L3)	3 3 3
3	18	21	2	Apply	L3	PO1, PO4, PO5	Apply (L3) Develop(L3) Apply(L3)	3 3 3
4	18	21	3	Design	L6	PO1, PO3, PO4	Apply (L3) Develop(L3) Analyze(L4)	3 3 3
5	18	21	3	Evaluate	L5	PO1, PO4, PO5	Apply (L3) Analyze(L4) Apply(L3)	3 3 3



Justification Statements:

CO1: Understand the principles and classifications of turbomachines (axial, radial, and mixed flow) and equations of motion in a rotating frame of reference, including Coriolis and centrifugal forces.

Action Verb: Understand (L2)

PO1Verb: Apply (L3)

CO1 Action verb is less than level as PO1 verb. Therefore, the correlation is medium (2).

PO2 Verb: Identify (L3)

CO1 Action verb is less than level as PO2 verb. Therefore, the correlation is medium (2).

PO3 Verb: Develop (L3)

CO1 Action verb is less than level as PO3 verb. Therefore, the correlation is medium (2).

CO2: Analyze gas turbine cycles including Brayton, regenerative, reheat and inter-cooled configurations and different engine types (turboprop, turbojet, turbofan) and thrust augmentation techniques.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: Develop (L3)

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3).

CO3: Apply similarity rules and specific speed concepts to turbo machinery models using tools like the Cordier diagram and aerodynamic performance of blade cascades through 2D analysis.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3).

PO4 Verb: Develop (L3)

CO3 Action verb is same level as PO4 verb. Therefore, the correlation is high (3).

PO5 Verb: Apply (L3)

CO3 Action verb is same level as PO5 verb. Therefore, the correlation is high (3).

CO4: Design axial and centrifugal compressors and pumps using velocity diagrams, h-s charts and other design methods, considering flow characteristics, tip clearance, slip factor, and losses.

Action Verb: Design (L6)

PO1 Verbs: Apply (L3)

CO4 Action Verb is same level (greater) as PO1 verb ; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3)

CO4 Action Verb is same level (greater) as PO3 verb ; Therefore, correlation is high (3).

PO4 Verbs: Analyze (L4)

CO4 Action Verb is same level (greater) as PO4 verb; Therefore, correlation is high (3).

CO5: Analyze axial flow turbines in terms of stage loading, efficiency, blade design and blade cooling methods and their impact on turbine performance

Action Verb: Evaluate (L5)

PO1 Verbs: Apply (L3)

CO5 Action Verb is same level (greater) as PO1 verb; Therefore, correlation is high (3).

PO4 Verbs: Analyze (L4)

CO5 Action Verb is same level (greater) as PO4 verb; Therefore, correlation is high (3).

PO5 Verbs: Apply (L3)

CO5 Action Verb is same level (greater) as PO5 verb; Therefore, correlation is high (3).



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0308	Control Systems	2	1	0	3

Course Outcomes:

- CO: 1 Develop mathematical models and transfer functions for mechanical and electrical control systems.
- CO: 2 Analyze and design control systems using block diagram algebra, signal flow graphs, and standard controllers (Lag, Lead, PID).
- CO: 3 Evaluate the stability and time-domain performance of control systems using Routh's criterion and root locus analysis.
- CO: 4 Analyze the frequency response and stability of control systems using Bode, Polar, and Nyquist plots.
- CO: 5 Develop state-space models for control systems and analyze their controllability and observability

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Develop	Mathematical models and transfer functions.	for mechanical and electrical control systems.		L6
CO2	Analyze	And design control systems.	using block diagram algebra, signal flow graphs, and standard controllers (Lag, Lead, PID).		L4, L6
CO3	Evaluate	The stability and time-domain performance of control systems.	using Routh's criterion and root locus analysis.		L5
CO4	Analyze	The frequency response and stability of control systems.	using Bode, Polar, and Nyquist plots.		L4
CO5	Develop	State-space models for control systems and.	analyze their controllability and observability		L6, L4

UNIT - I

BASICS IN CONTROL SYSTEM AND TRANSFER FUNCTION: Introduction of Control Systems, Various types of systems (Open Loop and closed loop) and their differences- Classification and Feed-Back Characteristics of control system- Effects of feedback. Mathematical models – Differential equations, Translational and Rotational mechanical systems. Transfer Function of DC Servo motor - AC Servo motor- Synchro transmitter and Receiver.

UNIT - II

REPRESENTATION OF TRANSFER FUNCTION AND CONTROL DESIGN TECHNIQUES: Block diagram representation of systems considering electrical systems as examples. Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula. Compensation techniques – Lag, Lead, Lead-Lag Controllers design, PID Controllers.

UNIT - III

TIME RESPONSE ANALYSIS: Standard test signals - Time response of first order systems – Characteristic Equation of Feedback control systems, Transient response of second order systems - Time domain specifications – Steady state response - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems. **STABILITY ANALYSIS:** The concept of stability – Routh's



stability criterion – qualitative stability and conditional stability – limitations of Routh's stability. The root locus concept - construction of root loci effects of adding poles and zeros to $G(s)$ $H(s)$ on the root loci.

UNIT - IV

FREQUENCY RESPONSE ANALYSIS: Introduction, Frequency domain Specifications-Bode diagrams Determination of Frequency domain specifications and transfer function from the Bode Diagram-Phase margin and Gain margin Stability Analysis from Bode Plots. **STABILITY ANALYSIS IN FREQUENCY DOMAIN:** Polar Plots-Nyquist Plots-Stability Analysis.

UNIT - V

STATE SPACE ANALYSIS: Concepts of state, state variables and state model, derivation of state models from block diagrams, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

Text Books:

1. I. J. Nagrath, M. Gopal (2011), Control Systems Engineering, 5th edition, New Age International (P) Limited, New Delhi, India.
2. Benjamin. C. Kuo (2003), Automatic Control Systems, 8th edition, John Wiley and Son's, USA

Reference Books:

1. K. Ogata (2008), Modern Control Engineering, 4th edition, Prentice Hall of India Pvt. Ltd, New Delhi.
2. N. K. Sinha (2008), Control System.
2. Prof. Vishwajit K. Barbudhe Control system Engineering National Press (2020)
3. Richard Dorf and Robert Bishop Modern Control Systems Pearson, 13th edition (2016).

Online Learning Resources:

1. <https://nptel.ac.in/courses/107106081>
2. <https://nptel.ac.in/courses/108107115>
3. <https://nptel.ac.in/courses/108103007>
4. <https://nptel.ac.in/courses/115108104>

CO-PO Mapping:

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Control Systems	CO1	3	3	2	2	-	-	-	-	-	-	-	3	2
	CO2	3	3	3	2	3	-	-	-	-	-	-	3	3
	CO3	3	3	2	3	2	-	-	-	-	-	-	3	3
	CO4	3	3	2	3	3	-	-	-	-	-	-	3	3
	CO5	3	3	3	2	2	-	-	-	-	-	-	3	3

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Develop	L6	PO1, PO2, PO3	Apply(L3) Analyze(L4) Design(L6)	3



MECHANICAL ENGINEERING (ME)

2				Analyze/Design	L4/L6	PO1, PO2, PO3, PO5	Analyze(L4) Design(L6) Usage(L3)	3
3				Evaluate	L5	PO1, PO2, PO4	Apply(L3) Analyze(L4) Analyze(L4)	3
4				Analyze	L4	PO1, PO2, PO4, PO5	Analyze(L4) Analyze(L4) Usage(L3)	3
5				Develop/Analyze	L6/L4	PO1, PO2, PO3	Apply(L3) Analyze(L4) Design(L6)	3

Justification Statements:

- **CO1:** Develop mathematical models and transfer functions for mechanical and electrical control systems.

Action Verb: Develop (L6)

PO1, PO2 & PO3 Verbs: Apply (L3), Analyze (L4), Design (L6)

The CO1 Action Verb 'Develop' (L6) is at a higher cognitive level than PO1 and PO2 verbs and is equivalent to PO3's 'Design' (L6). This outcome requires creating mathematical models from first principles to design systems. Therefore, the correlation is high (3).

- **CO2:** Analyze and design control systems using block diagram algebra, signal flow graphs, and standard controllers (Lag, Lead, PID).

Action Verbs: Analyze (L4) / Design (L6)

PO2, PO3 & PO5 Verbs: Analyze (L4), Design (L6), Usage (L3)

The CO2 Action Verbs 'Analyze' (L4) and 'Design' (L6) are at the same or higher cognitive levels as the verbs for PO2, PO3, and PO5. This outcome involves analyzing system behavior and designing controllers using modern engineering tools. Therefore, the correlation is high (3).

- **CO3:** Evaluate the stability and time-domain performance of control systems using Routh's criterion and root locus analysis.

Action Verb: Evaluate (L5)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4)

The CO3 Action Verb 'Evaluate' (L5) is a higher-order skill that requires the application of fundamental principles (PO1) and in-depth analysis (PO2, PO4) to make judgments about system stability and performance. Therefore, the correlation is high (3).

- **CO4:** Analyze the frequency response and stability of control systems using Bode, Polar, and Nyquist plots.

Action Verb: Analyze (L4)

PO2, PO4 & PO5 Verbs: Analyze (L4), Usage (L3)



The CO4 Action Verb 'Analyze' (L4) is at the same level as the verbs for PO2 and PO4 and requires the use of modern software tools (PO5) for plotting and analysis. It involves conducting investigations of complex problems in the frequency domain. Therefore, the correlation is high (3).

- **CO5:** Develop state-space models for control systems and analyze their controllability and observability.

Action Verbs: Develop (L6) / Analyze (L4)

PO1, PO2 & PO3 Verbs: Apply (L3), Analyze (L4), Design (L6)

The CO5 Action Verbs 'Develop' (L6) and 'Analyze' (L4) are at the same or higher cognitive levels than the verbs for PO1, PO2, and PO3. This outcome involves creating advanced models (a form of design) and analyzing system properties. Therefore, the correlation is high (3).



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0309	Operations Research	2	1	0	3

Course Outcomes:

- CO: 1 Apply the knowledge of operations research in solving linear programming problems
 CO: 2 Apply the mathematical procedure for solving the transportation and assignment models related to real world problems
 CO: 3 Evaluate the decisions to replace the items that deteriorate with time and to solve the game theory models
 CO: 4 Analyze the available resources based on the priority in solving the sequencing problems
 CO: 5 Analyze the simulation tools to develop the queuing and other relevant models

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	the knowledge of operations		research in solving linear programming problems	L3
CO2	Apply	the mathematical procedure for solving the transportation and assignment models		related to real world problems	L3
CO3	Evaluate	the decisions to replace the items that deteriorates with time and	to solve the game theory models		L5
CO4	Analyze	the available resources based on the priority		in solving sequencing problems	L4
CO5	Analyze	the simulation tools to develop the queuing and other relevant models			L3

Unit I:

Introduction to OR

Introduction to Operations Research (OR): OR definition - Classification of Models, modeling – Methods of solving OR Models, limitations and applications of OR models.

Linear Programming (LP): Problem Formulation, Graphical Method, Simplex Method, Big-M Method, Two-Phase Simplex Method, Special Cases of LP- Degeneracy, Infeasibility and Multiple Optimal Solutions; Concept of dual theorem

Unit II

Transportation and Assignment Problems

Transportation Problem – Formulation; Different Methods of Obtaining Initial Basic Feasible Solution –North West Corner Rule, Least Cost Method, Vogel's Approximation Method; Optimality Method – Modified Distribution (MODI) Method; Special Cases – Unbalanced Transportation Problem, Degenerate Problem. Assignment Problem – Formulation, Hungarian Method for Solving Assignment Problems, Traveling Salesman problem.

Unit III

Game theory & Job Sequencing

Game theory: Optimal solution of two-person zero sum games, the max min and min max principle. Games without saddle points, mixed strategies. Reduction by principles of dominance, arithmetic, algebraic method



and graphical method.

Job Sequencing: Introduction to Job shop Scheduling and flow shop scheduling, Solution of Job Sequencing Problem, Processing of n Jobs through two machines, Processing of n Jobs through m machines, graphical method.

Unit IV

Queuing Theory & Inventory Control

Queuing Theory: Introduction – Terminology, Arrival Pattern, Service Channel, Population, Departure Pattern, Queue Discipline, Birth & Death Process, Single Channel Models with Poisson Arrivals, Exponential Service Times with infinite and finite queue length; Multichannel Models with Poisson Arrivals, Exponential Service Times with infinite queue length.

Inventory Control: Introduction, Deterministic models – EOQ model with and without shortages, Production model, Buffer stock and discount inventory models with single price breaks. Selective inventory control.

Unit V

Replacement and Maintenance Analysis & DP

Replacement and Maintenance Analysis: Introduction – Types of Maintenance, Make or buy decision. Types of Replacement Problems, Determination of Economic Life of an Asset, and Simple Probabilistic Model for Items which completely fail-Individual Replacement Model, Group Replacement Model.

Dynamic Programming (DP): Introduction – Bellman's Principle of Optimality – Applications of Dynamic Programming – Shortest Path Problem – Capital Budgeting Problem – Solution of Linear Programming Problem by DP.

Text Books:

1. Sharma S.D., Operations Research: Theory, Methods and Applications, 15/e, Kedar Nath Ram Nath, 2010
2. Taha H.A., Operations Research, 9/e, Prentice Hall of India, New Delhi, 2010

Reference Books:

1. Hiller F.S., and Liberman G.J., Introduction to Operations Research, 7/e, Tata McGraw Hill, 2010.
2. Sharma J.K., Operations Research: Theory and Applications, 4/e, Laxmi Publications, 2009.
3. Prem kumar Gupta and Hira, Operations Research, 3/e, S Chand Company Ltd., New Delhi, 2003.
4. Pannerselvam R., Operations Research, 2/e, Prentice Hall of India, New Delhi, 2006.
5. Sundaresan.V, and Ganapathy Subramanian.K.S, Resource Management Techniques: Operations Research, A.R Publications, 2015.

Online Learning Resources:

- <http://www2.informs.org/Resources/>
- <http://www.mit.edu/~orc/>
- <http://www.ieor.columbia.edu/>
- <http://www.universalteacherpublications.com/univ/ebooks/or/Ch1/origin.htm>
- <http://www.wolfram.com/solutions/OperationsResearch/>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Operations Research	CO1	3	3	3									2	2
	CO2	3	3	3									1	2
	CO3	3	3	3	1								2	2
	CO4	3	3										2	2
	CO5		3	3		3							2	2



Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	9/60	15	L2	Apply	L3	PO1	Apply (L3)	3
						PO2	Formulate (L3)	3
						PO3	Develop (L3)	3
2	19/60	31	L3	Apply	L3	PO1	Apply (L3)	3
						PO2	Identify (L3)	3
						PO3	Develop (L3)	3
3	14/60	23	L3	Evaluate	L5	PO1	Apply (L3)	3
						PO2	Identify (L3)	3
						PO3	Develop (L3)	3
						PO4	Design (L6)	1
4	8/60	13	L2	Analyze	L4	PO1	Apply (L3)	3
						PO2	Identify (L3)	3
5	10/60	16	L2	Analyze	L4	PO2	Apply (L3)	3
						PO3	Develop (L3)	3
						PO5	Apply (L3)	3

Justification Statements:

CO1: Apply the knowledge of operations research in solving linear programming problems

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: Formulate (L3)

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: Develop (L3)

CO1: Action verb is same level as PO3 verb. Therefore, the correlation is high (3).

CO2: Apply the mathematical procedure for solving the transportation and assignment models related to real world problems.

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

CO2: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Develop (L3)

CO2: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: Apply (L3)

CO2: Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Evaluate the decisions to replace the items that deteriorate with time and to solve the game theory models.

Action Verb: Evaluate (L5)

PO1 Verb: Apply (L3)

CO3: Action verb is same (greater) level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: Identify (L3)

CO3: Action verb is same (greater) level as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: Develop (L3)

CO3: Action verb is same (greater) level as PO3 verb. Therefore, the correlation is high (3).

PO4 Verb: Design (L6)



CO3: Action verb is same (lower) level as PO4 verb. Therefore, the correlation is low (1).

CO4: Analyze the available resources based on the priority in solving the sequencing problems.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO5: Analyze the simulation tools to develop the queuing and other relevant models

Action Verb: Analyze (L4)

PO2 Verb: **Apply (L3)**

CO5: Action verb is same level as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: **Develop (L3)**

CO5: Action verb is same level as PO3 verb. Therefore, the correlation is high (3).

PO5 Verb: **Apply (L3)**

CO5: Action verb is same level as PO5 verb. Therefore, the correlation is high (3).



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0310	Smart Materials	2	1	0	3

Course Outcomes:

- CO: 1 Understand the types and components of smart materials for various engineering applications.
- CO: 2 Understand the working principles, properties, and applications of different smart materials for specific engineering and technological applications.
- CO: 3 Apply the suitable processing and fabrication techniques of various smart materials in engineering applications.
- CO: 4 Analyze the various sensor technologies and choose appropriate sensors for engineering applications.
- CO: 5 Apply the working mechanisms of various actuators of different smart materials to create system applications.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the types and components of smart materials		for various engineering applications.	L2
CO2	Understand	the working principles, properties, and applications of different smart materials		for specific engineering and technological applications.	L2
CO3	Apply	the suitable processing and fabrication techniques		of various smart materials in engineering applications.	L3
CO4	Analyze	the various sensor technologies and choose appropriate sensors		for engineering applications.	L4
CO5	Apply	the working mechanisms of various actuators of different smart materials to create system applications			L3

Unit I: Introduction: Characteristics of metals, polymers and ceramics. Introduction to smart materials. Classification of smart materials, Components of a smart System, Applications of smart material.

Unit II

Smart Materials Piezoelectric materials, Electrostrictive Materials, Magnetostrictive materials, Magnetoelectric materials, Magnetorheological Electrorheological fluids, Shape Memory materials.

Unit III

Processing of Smart Materials Semiconductors and their processing, Metals and metallization techniques, Ceramics and their processing, Polymers and their synthesis, UV radiation curing of polymers, fluids.

Unit IV

Sensors Introduction, Conductometric sensors, Capacitive sensors, Piezoelectric sensors, Magnetostrictive sensors, Piezoresistive sensors, Optical sensors, Resonant sensors, semiconductor based sensors, Acoustic sensors, polymerize sensors, Carbon nanotube sensors.

Unit V

Actuators Introduction, Electrostatic transducers, Electromagnetic transducers, Electrodynamical transducers, Piezoelectric transducers, Electrostrictive transducers, Magnetostrictive transducers, Electrothermal actuators, Comparison of actuation, Applications



Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

Text Books:

1. Smart Material Systems and MEMS: Design and Development Methodologies, V. K. Varadan, K. J. Vinoy, S. Gopalakrishnan, John Wiley and Sons, England, 2006.
2. Smart Structures and Materials, Brain Culshaw, Artech House, London, 1996.
3. Smart Materials and Structures, Mukesh V. Gandhi, Brian S. Thompson, , Springer, May

Reference Books:

1. Smart Structures: Analysis and Design, A. V. Srinivasan, Cambridge University Press, Cambridge, New York, 2001.
2. Smart Structures, P. Gauenzi, Wiley, 2009.
3. Piezoelectric Sensorics: Force, Strain, Pressure, Acceleration and Acoustic Emission Sensors, Materials and Amplifiers, G. Gautschi, Springer, Berlin, New York, 2002.
4. Analysis and Performance of Fiber Composites, B. D. Agarwal and L. J. Broutman, John Wiley & Sons.
5. Engineering aspects of Shape memory Alloys, T. W. Duerig, K. N. Melton, D. Stockel, C. Mayman, Butterworth – Heinemann, 1990.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Smart Materials	CO1	2	2			2							3	
	CO2	2	2			2							3	
	CO3	3	3			3							3	
	CO4	3	3			3							3	
	CO5	3	3			3							3	

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Understand	L2	PO1 PO2 PO5	Apply (L3) Develop (L3) Apply (L3)	2 2 2
2				Understand	L2	PO1 PO2 PO5	Apply (L3) Develop (L3) Apply (L3)	2 2 2
3				Apply	L3	PO1 PO2 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
4				Analyze	L4	PO1 PO2 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3
5				Apply	L3	PO1 PO2 PO5	Apply (L3) Develop (L3) Apply (L3)	3 3 3

Justification Statements:

CO1: Understand the types and components of smart materials for various engineering applications

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is less than level of PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Develop (L3)**

CO1 Action verb is less than level of PO2 verb. Therefore, the correlation is medium (2)



PO5 Verb: **Apply (L3)**

CO1: Action verb is less than level of PO5 verb. Therefore, the correlation is medium (2)

CO2: Understand the working principles, properties, and applications of different smart materials for specific engineering and technological applications.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO2 Action verb is less than level of PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Develop (L3)**

CO2 Action verb is less than level of PO2 verb. Therefore, the correlation is medium (2)

PO5 Verb: **Apply (L3)**

CO2: Action verb is less than level of PO5 verb. Therefore, the correlation is medium (2)

CO3: Apply the suitable processing and fabrication techniques of various smart materials in engineering applications.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO3: Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO4: Analyze the various sensor technologies and choose appropriate sensors for engineering applications

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4: Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO4: Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO4: Action verb is greater than PO5 verb. Therefore, the correlation is high (3)

CO5: Apply the working mechanisms of various actuators of different smart materials to create system applications.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO5: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO5: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO5: Action verb is same level as PO5 verb. Therefore, the correlation is high (3)



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0311	Applications of Computational Fluid dynamics	2	1	0	3

Course Outcomes:

- CO: 1 Formulate and solve partial differential equations using various finite difference and finite element methods.
- CO: 2 Analyze the stability and accuracy of explicit and implicit numerical schemes for solving hyperbolic and non-linear partial differential equations.
- CO: 3 Create numerical formulations for incompressible and compressible viscous flows using appropriate boundary conditions.
- CO: 4 Develop and implement finite volume formulations to solve multi-dimensional fluid flow and heat transfer problems.
- CO: 5 Analyze and solve linear, steady-state, and transient fluid flow problems using standard variational methods

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Formulate	And solve partial differential equations.	using various finite difference and finite element methods.		L6
CO2	Analyze	The stability and accuracy of explicit and implicit numerical schemes.	for solving hyperbolic and non-linear partial differential equations.		L4
CO3	Create	Numerical formulations for incompressible and compressible viscous flows.	using appropriate boundary conditions.		L6
CO4	Develop	And implement finite volume formulations.	to solve multi-dimensional fluid flow and heat transfer problems.		L6
CO5	Analyze	And solve linear, steady-state, and transient fluid flow problems.	using standard variational methods.		L4

Unit I:

Introduction: Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

Solution methods: Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tridiagonal matrix algorithm.

Unit II

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi-step methods, nonlinear problems, second order one-dimensional wave equations. Burger's equations: Explicit and implicit schemes, Runge-Kutta method.



Unit III

Formulations Of Incompressible Viscous Flows: Formulations of incompressible viscous flows by finitedifference methods, pressure correction methods, vortex methods.

Treatment of compressible flows: potential equation, Euler equations, Navier-stokes system of equations, flowfield-dependent variation methods, boundary conditions, example problems.

Unit IV

Finite Volume Method Finite volume method via finite difference method, formulations for two and three-dimensional problems.

Unit V

Standard Variational Methods Linear fluid flow problems, steady state problems, Transient problems.

Text Books:

1. T. J. C'hung, Computational fluid dynamics, Cambridge University press, 2002.
2. John D. Anderson, Computational Fluid Dynamics: Basics with applications, Mc Graw Hill. 2017

Reference Books:

1. Frank Choriton, Text book of fluid dynamics, CBS Publishers & distributors, 1985.
2. Suhas V. Patankar, Numerical heat transfer and fluid flow, Hema shava Publishers corporation & McGraw Hill, 1990.
3. Muralidaran, Computational Fluid Flow and Heat Transfer, Narosa Publications, 2003.
4. Tapan K. Sengupta, Fundamentals of Computational Fluid Dynamics, Universities Press, 2004.
5. C. Pozrikidis, Introduction to Theoretical and Computational Fluid Dynamics, Oxford University press, 2/e, 2012.

Online Learning Resources:

- <https://nptel.ac.in/courses/112107079>
- <https://www.youtube.com/watch?v=3QFT7pGx03I>
- https://www.youtube.com/watch?v=t7jS7V_6TGQ
- <https://nptel.ac.in/courses/112107080>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Applications of Computational Fluid Dynamics	CO1	3	3	2	2	-	-	-	-	-	-	-	3	3
	CO2	3	3	-	3	2	-	-	-	-	-	-	3	3
	CO3	3	3	3	2	3	-	-	-	-	-	-	3	3
	CO4	3	3	3	2	3	-	-	-	-	-	-	3	3
	CO5	3	3	2	3	-	-	-	-	-	-	-	3	3

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours (%)			CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Formulate	L6	PO1, PO2, PO3, PO4	Apply(L3) Analyze(L4) Design(L6) Analyze(L4),	3
2				Analyze	L4	PO1, PO2, PO4, PO5	Apply(L3) Analyze(L4) Analyze(L4) Usage(L3)	3



MECHANICAL ENGINEERING (ME)

3				Create	L6	PO1, PO2, PO3, PO5	Apply(L3) Analyze(L4) Design(L6) Usage(L3)	3
4				Develop	L6	PO1, PO2, PO3, PO5	Apply(L3) Analyze(L4) Design(L6) Usage(L3)	3
5				Analyze	L4	PO1, PO2, PO3, PO4	Apply(L3) Analyze(L4) Design(L6) Analyze(L4)	3

Justification Statements:

- **CO1:** Formulate and solve partial differential equations using various finite difference and finite element methods.

Action Verb: Formulate (L6)

PO1, PO2, & PO3 Verbs: Apply (L3), Analyze (L4), Design (L6)

The CO1 Action Verb 'Formulate' (L6) is at a higher cognitive level than PO1 and PO2 and is equivalent to PO3's 'Design' (L6). This outcome requires formulating solutions to complex engineering problems from first principles. Therefore, the correlation is high (3).

- **CO2:** Analyze the stability and accuracy of explicit and implicit numerical schemes for solving hyperbolic and non-linear partial differential equations.

Action Verb: Analyze (L4)

PO2, PO4, & PO5 Verbs: Analyze (L4), Analyze (L4), Usage (L3)

The CO2 Action Verb 'Analyze' (L4) is at the same level as the verbs for PO2 and PO4 and requires the use of modern tools (PO5). It involves conducting investigations of complex problems. Therefore, the correlation is high (3).

- **CO3:** Create numerical formulations for incompressible and compressible viscous flows using appropriate boundary conditions.

Action Verb: Create (L6)

PO2, PO3, & PO5 Verbs: Analyze (L4), Design (L6), Usage (L3)

The CO3 Action Verb 'Create' (L6) is equivalent to 'Design' (PO3). This process necessitates analyzing complex problems (PO2) and applying modern engineering tools (PO5) to develop solutions. Therefore, the correlation is high (3).

- **CO4:** Develop and implement finite volume formulations to solve multi-dimensional fluid flow and heat transfer problems.

Action Verb: Develop (L6)

PO2, PO3, & PO5 Verbs: Analyze (L4), Design (L6), Usage (L3)

The CO4 Action Verb 'Develop' (L6) is synonymous with 'Design' (PO3). Developing these formulations requires analyzing the problem (PO2) and using modern tools (PO5) for implementation. Therefore, the correlation is high (3).

- **CO5:** Analyze and solve linear, steady-state, and transient fluid flow problems using standard variational methods.

Action Verb: Analyze (L4)

PO1, PO2, & PO4 Verbs: Apply (L3), Analyze (L4), Analyze (L4)



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MECHANICAL ENGINEERING (ME)

The CO5 Action Verb 'Analyze' (L4) is at a higher level than PO1's verb and equal to the verbs for PO2 and PO4. This involves applying principles of mathematics and engineering sciences to analyze complex problems. Therefore, the correlation is high (3).



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0312	Industrial Safety	2	1	0	3

Course Outcomes:

- CO: 1 Analyze the principles of industrial safety management and the roles of various safety organizations.
- CO: 2 Apply accident prevention techniques, including the investigation process and the selection of personal protective equipment.
- CO: 3 Analyze key industrial safety acts and standards to ensure legal compliance and workplace health.
- CO: 4 Evaluate fire hazards and select appropriate fire prevention and protection systems for various industrial scenarios.
- CO: 5 Apply fire safety principles in building design to ensure structural integrity and plan for safe egress

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	The principles of industrial safety management and the roles of various safety organizations.			L4
CO2	Apply	Accident prevention techniques.	including the investigation process and the selection of personal protective equipment.		L3
CO3	Analyze	Key industrial safety acts and standards.	to ensure legal compliance and workplace health.		L4
CO4	Evaluate	Fire hazards and select appropriate fire prevention and protection systems.	for various industrial scenarios.		L5
CO5	Apply	Fire safety principles in building design.	to ensure structural integrity and plan for safe egress.		L3

UNIT-I

INTRODUCTION TO THE DEVELOPMENT OF INDUSTRIAL SAFETY AND MANAGEMENT:

History and development of Industrial safety: Implementation of factories act, Safety and productivity, Safety organizations. Safety committees and structure, Role of management and role of Govt.in industrial safety.

UNIT-II

ACCIDENT PREVENTIONS AND PROTECTIVE EQUIPMENT: Personal protective equipment, Survey the plant for locations, Part of body to be protected, Education and training in safety, Prevention causes and cost of accident, Housekeeping, First aid, Accident reporting, Investigations. Industrial psychology in accident prevention, Safety trials, Safety related to operations.

UNIT-III

SAFETY ACTS: Features of Factory Act, Introduction of Explosive Act, Boiler Act, ESI Act, Workman's compensation Act, Industrial hygiene, Occupational safety, Diseases prevention, Ergonomics, Occupational diseases, stress, fatigue, health, safety and the physical environment, Engineering methods of controlling chemical hazards, safety and the physical environment, Control of industrial noise and protection against it, Code and regulations for worker safety and health, codes for safety of systems.

UNIT-IV

FIRE PREVENTION AND PROTECTION: Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E-Fire extinguishing agents- Water, Foam, Dry chemical powder, Carbon-dioxide Halon alternatives Halocarbon compounds-Inert gases, dry powders – types of fire extinguishers – fire stoppers –hydrant pipes – hoses – monitors – fire watchers – layout of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills –first aid for burns.

UNIT-V

BUILDING FIRE SAFETY: Objectives of fire safe building design, Fire load, fire resistant material and fire testing – structural fire protection – structural integrity – concept of egress design -exit– width calculations – fire certificates – fire safety requirements for high rise buildings.

TEXT BOOKS:

1. Occupational Safety Management and Engineering Willie Hammer—PrenticeHall (2000)
2. Purandare D.D & Abhav D.Purandare, —Handbook on Industrial Fire Safety P&Apublications, NewDelhi.

REFERENCE BOOKS:

1. Installation, Servicing and Maintenance Bhattacharya, S.N.-S.Chandand Co.
2. Jain VK —Fire Safety in Building|| New Age International 1996.
3. Reliability, Maintenance and Safety Engineering by Dr.A. K.Guptha
4. A Text book of Reliability and Maintenance Engineering by Alakesh Manna
5. McElroy, Frank E.,—Accident Prevention Manual for Industrial Operations||, NSC, Chicago, 1988.
6. Green, A.E.,—High Risk Safety Technology||, John Wiley and Sons, 1984.

Online Learning Resources:

- <https://nptel.ac.in/courses/110105094>
- https://youtube.com/playlist?list=PLbRMhDVUMngdXebaRB59KdKwstzuAovua&si=FcbDQzZK6i_3TASD
- <https://youtube.com/playlist?list=PLbRMhDVUMngdXebaRB59KdKwstzuAovua&si=6RaMiYhEkp5-EfAH>
- <https://youtube.com/playlist?list=PLln3BHg93SQ8RYKhe9czOHq1hVjpEWMts&si=5y0WMqX3wrvvispq>

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Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours (%)			CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Analyze	L4	PO1, PO2, PO4	Apply(L3), Analyze(L4), Analyze(L4)	3
2				Apply	L3	PO1, PO2, PO4	Apply(L3), Analyze(L4), Analyze(L4)	3
3				Analyze	L4	PO2, PO4	Analyze(L4), Analyze(L4)	3
4				Evaluate	L5	PO1, PO2, PO3, PO4	Analyze(L4), Design(L6), Analyze(L4)	3
5				Apply	L3	PO1, PO3	Apply(L3) Design(L6)	3

Justification Statements:

- CO1:** Analyze the principles of industrial safety management and the roles of various safety organizations.

Action Verb: Analyze (L4)

PO2 & PO4 Verbs: Analyze (L4)

The CO1 Action Verb 'Analyze' (L4) is at the same cognitive level as the verbs for PO2 and PO4. This outcome requires analyzing complex problems related to safety management systems. Therefore, the correlation is high (3).

- CO2:** Apply accident prevention techniques, including the investigation process and the selection of personal protective equipment.

Action Verb: Apply (L3)

PO1 & PO5 Verbs: Apply (L3), Usage (L3)

The CO2 Action Verb 'Apply' (L3) is at the same cognitive level as the verbs for PO1 and PO5 and is a prerequisite for analysis (PO2, PO4). It involves applying engineering knowledge and tools for accident prevention. Therefore, the correlation is high (3).

- CO3:** Analyze key industrial safety acts and standards to ensure legal compliance and workplace health.

Action Verb: Analyze (L4)

PO2 & PO4 Verbs: Analyze (L4)

The CO3 Action Verb 'Analyze' (L4) is at the same cognitive level as the verbs for PO2 and PO4. The outcome requires analyzing legal documents and standards to solve complex safety problems. Therefore, the correlation is high (3).

- CO4:** Evaluate fire hazards and select appropriate fire prevention and protection systems for various industrial scenarios.

Action Verb: Evaluate (L5)

PO2, PO3 & PO4 Verbs: Analyze (L4), Design (L6)



Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

The CO4 Action Verb 'Evaluate' (L5) is a higher-order skill that requires analysis (PO2, PO4) and is a critical component of designing solutions (PO3). The ability to make judgments is fundamental to these POs. Therefore, the correlation is high (3).

- **CO5:** Apply fire safety principles in building design to ensure structural integrity and plan for safe egress.

Action Verb: Apply (L3)

PO1 & PO3 Verbs: Apply (L3), Design (L6)

The CO5 Action Verb 'Apply' (L3) is at the same level as PO1's verb and is a foundational skill for 'Design' (PO3). This outcome involves applying engineering principles to the design of safe structures. Therefore, the correlation is high (3)



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0313	Design of Automobile Transmission Systems	2	1	0	3

Course Outcomes:

- CO: 1 Understand the operation of engine components and working of cooling and lubrication systems
- CO: 2 Apply the concept of fuel supply system to SI and CI engines of an automobile
- CO: 3 Apply the knowledge of various ignition systems to SI engines.
- CO: 4 Analyze the working of various components in transmission systems
- CO: 5 Apply the knowledge of suspension and braking systems to different kinds of engines

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the use and operation of engine components and working of cooling and lubrication systems			L2
CO2	Apply	the concept of fuel supply system	to SI and CI engines of an automobile		L3
CO3	Apply	the knowledge of ignition systems	to SI engines		L3
CO4	Analyze	the working of transmission systems			L4
CO5	Apply	the knowledge of suspension and braking systems	to different kinds of engines		L3

Unit I:

Engine Parts: Function and constructional details of Cylinder block, Cylinder liners-wet and dry types, Piston, Connecting rods, Crankshaft, Camshaft, Air cleaner, Intake and Exhaust manifolds, Mufflers. Cooling System: Need for cooling of automobile-Types of cooling-air cooling, water-cooling. Natural circulation (Thermo-syphon system), Forced circulation and sealed Systems. Components of water-cooling system. Water pump, fan, Radiator, Thermostats and temperature indicators. Anti-freeze mixtures.

Lubricating Systems: Need for lubrication-Functions of lubricating oil. Properties of lubricating oil, and S.A.E grading of lubricants. Lubricating systems-Petrol .Splash, Pressure feed, Wet and Dry sump, Semi pressure and pre-lubrication system

Unit II

Fuel Supply Systems: Fuel supply system of diesel engine, fuel injection pumps, Super charging of diesel engines. Fuel supply system for petrol engines-Carburetors, Air-fuel ratios at different vehicle running conditions, Working of a simple carburetor. Various carburetor systems- Float, Starting, Idle, Low speed, High speed and acceleration systems. MPFI and EFI systems. Types of carburetors- Working and constructional details of SU, Zenith and Carter carburetors

Unit III

Ignition-System: Electronic ignition system. Storage battery, Battery rating, Dynamo, Alternators, Cut outs, Voltage and Current regulators. Starting motors. Sparkplugs-Hot and Cold, Computer controlled coil ignition sensors

Unit IV

Transmission System: Clutch-Principle and requirements of a clutch, types of clutches-Single plate, Multi plate and Centrifugal, Semi-centrifugal clutches. Gearbox - Requirements of a gear box, Gear selecting mechanism, Types of gear boxes -Sliding mesh, Constant mesh and Synchromesh. Propeller shaft Functions



and constructional details, Differential: Principle of working and its construction, Front axle-stub axle-types of stub axles. Rear axle –Semi floating, Three-quarter floating and Full floating axles. Steering-Wheel alignment. Steering geometry-Camber-Castor, Kingpin inclination, Toe in, and Toe-out. Steering linkages-Under steering and over steering. Power steering

Unit V

Suspension: Types of suspension springs, Front axle independent suspension systems-Wishbone type. Trailing link type, Vertical link type. Rear axle suspension systems, Shock absorbers, Air suspension system Brakes: Requirements of good braking system. Types of brakes-Mechanical, Hydraulic and pneumatic systems Emission control, environmental effects on engines, Euro Standards and Bharat Stage Emission Norms.

Text Books:

1. Kirpal Singh, Automobile Engineering Vol.1&2, Standard Publishers, New Delhi
2. R.B. Gupta, Automobile Engineering, Satya Prakasam Publishers, New Delhi

Reference Books

1. W.H. Crowse, Automotive Mechanics, TMH Publishers, New Delhi
2. Joseph Heitner, Automotive Mechanics, EWP Publishers, New Delhi
3. Heldt, High Speed Combustion Engines, Oxford and IBH Publishers, New Delhi.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Design of Automobile Transmission Systems	CO1	2	2	2									1	1
	CO2	3	3	3									2	2
	CO3	3	3										2	2
	CO4	3	3										2	2
	CO5	3	3					2	2				1	1

Correlation Matrix

CO				CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	12	17.64	L2	Understand	2	PO1 PO2 PO3	Apply (L3) Identify(L3) Develop (L3)	2 2 2
2	11	16.17	L2	Apply	3	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop (L3)	3 3 3
3	9	13.23	L2	Apply	3	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	22	32.35	L3	Analyze	4	PO1 PO2 PO4	Apply (L3) Identify (L3) Analyze(L4)	3 3 3
5	14	20.5	L3	Apply	5	PO1 PO2 PO7 PO8	Apply (L3) Identify (L3) Thumb Rule Thumb Rule	3 3 2 2

Justification Statements:

CO1: Understand the operation of engine components and working of cooling and lubrication systems.

Action Verb: Understand (L2)

PO1 Verb: Apply (L3) CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: Identify (L3)

CO1 Action verb is one level than as PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: Develop (L3)



CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)

CO2: Apply the concept of fuel supply system to SI and CI engines of an automobile

Action Verb: Apply (L3)

PO1 Verb: Apply (L3) CO2 Action verb is same level as PO1 verb.

Therefore, the correlation is high (3) PO2 Verb: Identify (L3)

CO2 Action verb is same level as PO2 verb.

Therefore, the correlation is high (3) PO3 Verb: Develop (L3)

CO2 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO3: Apply the knowledge of various ignition systems to SI engines.

Action Verb: Apply (L3)

PO1 Verb: Apply (L3)

Action Verb: Apply (L3)

PO1 Verb: Apply (L3) CO3 Action verb is same level as PO1 verb.

Therefore, the correlation is high (3) PO2 Verb: Identify (L3)

CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO4: Analyze the working of various components in transmission systems.

Action Verb: Analyze (L4) PO1 Verb: Apply (L3)

CO4 Action verb is greater level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3) CO4 Action verb is greater level as PO2 verb.

Therefore, the correlation is high (3)

PO4 Verb: Analyze (L4) CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

CO5: Apply the knowledge of suspension and braking systems to different kinds of engines

Action Verb: Apply (L3)

PO1 Verb: Apply (L3) CO5 Action verb is same level as PO1 verb.

Therefore, the correlation is high (3) PO2 Verb: Identify (L3)

CO5 Action verb is greater level as PO2 verb. Therefore, the correlation is high (3) PO7 Verb:

Thumb Rule CO5 In addition to reducing carbon emissions sustainable practices can help the automobile industry become more efficient and reduce waste.

Therefore, the correlation is medium (2) PO8 Verb:

Thumb Rule CO5 Emissions from vehicles are a major cause of Environmental pollution. Therefore, the correlation is medium (2)



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0314	Mechanics & Manufacturing of Composite Materials	2	1	0	3

Course Outcomes:

- CO: 1 Understand the characteristics of different types of composite materials, and explain various fiber-reinforced plastic processing methods
- CO: 2 Evaluate the elastic moduli of composite laminas, apply Hooke's law to different material types and solve numerical problems
- CO: 3 Analyze the failure of composite laminates, and perform macro-mechanical analysis using Classical Laminate Theory (CLT), for various laminate configurations through numerical problem-solving.
- CO: 4 Understand the appropriate reinforcements and base metals for MMCs and various fabrication processes
- CO: 5 Analyze the failure mechanisms of unidirectional lamina using micromechanical models and apply suitable failure theories through practical examples

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the characteristics of different types of composite materials, and explain various fiber-reinforced plastic processing methods		for various engineering applications.	L2
CO2	Evaluate	the elastic moduli of composite laminas, apply Hooke's law to different material types		different material types and solve numerical problems	L5
CO3	Analyze	the failure of composite laminates, and perform macro-mechanical analysis using Classical Laminate Theory (CLT)		For engineering problem solving.	L4
CO4	Understand	the appropriate reinforcements and base metals for MMCs and various fabrication processes		for engineering applications.	L2
CO5	Analyze	the failure mechanisms of unidirectional lamina using micromechanical models and suitable failure theories.			L4

Unit I:

Introduction to Composite Materials: Definition, classification and characteristics of composite Materials – fibrous composites, laminated composites, particulate composites. **Applications:** Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, Marine, recreational and sports equipment, future potential of composites.

Fiber Reinforced Plastic Processing: Lay-up and curing, fabricating process, open and closed mould process, hand lay-up techniques; structural laminate bag molding, production procedures for bag molding; filament winding, pultrusion, pulforming, thermo-forming, injection molding, blow molding.

Unit II:

Micro Mechanical Analysis of a Lamina: Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli by Rule of mixture, Numerical problems.

Macro Mechanics of a Lamina: Hooke's law for different types of materials, Number of elastic constants, Two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - Numerical problems. Stress-Strain relations for lamina of arbitrary orientation, Numerical problems.



Unit III:

Biaxial Strength Theories Maximum stress theory, Maximum strain theory, Tsai-Hill theory, Tsai, Wu tensor theory, Numerical problems.

Macro Mechanical Analysis of Laminate

Introduction, code, Kirchoff hypothesis, CL T, A, B, and D matrices (Detailed derivation), Special cases of laminates, Numerical problems.

Unit IV

Metal Matrix Composites: Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals selection. Need for production MMC's and its application.

Fabrication Process for MMC's: Powder metallurgy technique, liquid metallurgy technique and secondary processing, special fabrication techniques.

Study Properties of MMC's: Physical Mechanical, Wear, machinability and Other Properties. Effect of size, shape and distribution of particulate on properties.

Unit V

Failure Theories: Micromechanics of Failure of Unidirectional Lamina, Anisotropic Strength and Failure Theories, Importance of Shear Strength, Choice of Failure Criteria, Examples.

Text Books:

1. K.K. Chawla, Composite Materials, Springer-Verlag, New York, 1998.
2. B.T. Astrom, Manufacturing of Polymer Composites, Chapman & Hall, 1997.
3. Stuart M Lee, J. Ian Gray, Miltz, Reference Book for Composites Technology, CRC press, 1989.

Reference Books:

1. Frank L Matthews and R D Rawlings, Composite Materials: Engineering and Science, Taylor and Francis, 2006.
2. D. Hull and T.W. Clyne, Introduction to Composite Materials, Cambridge University Press, 1996.
3. M.R. Piggott, Load Bearing Fibre Composites, Pergamon press, Oxford, 1998.
4. F. Ashby and D.R.H. Jones, Engineering Materials, Pergamon press, 1999.
5. R.W. Davidge and A. Kelly, Mechanical behavior of ceramics, Cambridge university press, 1999.
6. Andrew C. Marshall, Composite Basics, Marshall Consulting. Mode of Evaluation Quiz /Assignment / Seminar / Written Examination, 1998

Online Learning Resources:

- <https://nptel.ac.in/courses/112104221>
- <https://nptel.ac.in/courses/112104229>
- <https://nptel.ac.in/courses/112104161>
- https://onlinecourses.nptel.ac.in/noc22_me40/preview

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Mechanics & Manufacturing of Composite Materials	CO1	2	2			2							3	
	CO2	3	3			3							3	
	CO3	3	3			3							3	
	CO4	2	2			2							3	
	CO5	3	3			3							3	



Correlation Matrix

CO				CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Understand	L2	PO1	Apply (L3)	2
						PO2	Develop (L3)	2
						PO5	Apply (L3)	2
2				Evaluate	L5	PO1	Apply (L3)	3
						PO2	Develop (L3)	3
						PO5	Apply (L3)	3
3				Analyze	L4	PO1	Apply (L3)	3
						PO2	Develop (L3)	3
						PO5	Apply (L3)	3
4				Understand	L2	PO1	Apply (L3)	2
						PO2	Develop (L3)	2
						PO5	Apply (L3)	2
5				Analyze	L4	PO1	Apply (L3)	3
						PO2	Develop (L3)	3
						PO5	Apply (L3)	3

Justification Statements:

CO1: Understand the characteristics of different types of composite materials, and explain various fiber-reinforced plastic processing methods

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is less than one level of PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Develop (L3)**

CO1 Action verb is less than one level of PO2 verb. Therefore, the correlation is medium (2)

PO5 Verb: **Apply (L3)**

CO1: Action verb is less than one level of PO5 verb. Therefore, the correlation is medium (2)

CO2: Evaluate the elastic moduli of composite laminas, apply Hooke's law to different material types and solve numerical problems

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO2 Action verb is greater than level of PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO2 Action verb is greater than level of PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO2: Action verb is greater than level of PO5 verb. Therefore, the correlation is high (3)

CO3: Analyze the failure of composite laminates, and perform macro-mechanical analysis using Classical Laminate Theory (CLT), for various laminate configurations through numerical problem-solving

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO3: Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO3: Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO3: Action verb is greater than PO5 verb. Therefore, the correlation is high (3)

CO4: Understand the appropriate reinforcements and base metals for MMCs and various fabrication processes



Action Verb: understand (L2)

PO1 Verb: **Apply (L3)**

CO4: Action verb is less than one level of PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Develop (L3)**

CO4: Action verb is less than one level than PO2 verb. Therefore, the correlation is medium (2)

PO5 Verb: **Apply (L3)**

CO4: Action verb is less than one level PO5 verb. Therefore, the correlation is medium (2)

CO5: Analyze the failure mechanisms of unidirectional lamina using micromechanical models and apply suitable failure theories through practical examples

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO5: Action verb is greater than as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Develop (L3)**

CO5: Action verb is greater than as PO2 verb. Therefore, the correlation is high (3)

PO5 Verb: **Apply (L3)**

CO5: Action verb is greater than as PO5 verb. Therefore, the correlation is high (3)



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0315	Introduction to hybrid and electric vehicles	2	1	0	3

Course Outcomes:

- CO: 1 Analyze electric vehicle propulsion systems and evaluate the performance of various energy storage technologies.
- CO: 2 Design and analyze power electronic converters and their control strategies for electric vehicle drives.
- CO: 3 Analyze and compare the architectures and power flow control of various hybrid and electric drivetrain topologies.
- CO: 4 Evaluate the system integration and control strategies of commercial hybrid and electric vehicles through case studies.
- CO: 5 Design key components of a hybrid vehicle powertrain and develop appropriate energy management strategies

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	Electric vehicle propulsion systems and evaluate the performance of various energy storage technologies.			L4
CO2	Design	And analyze power electronic converters and their control strategies.	for electric vehicle drives.		L6
CO3	Analyze	And compare the architectures and power flow control of various hybrid and electric drivetrain topologies.			L4
CO4	Evaluate	The system integration and control strategies of commercial hybrid and electric vehicles.	through case studies.		L5
CO5	Design	Key components of a hybrid vehicle powertrain and develop appropriate energy management strategies.			L6

Unit I:

Electric Vehicle Propulsion and Energy Sources

Introduction to electric vehicles, vehicle mechanics - kinetics and dynamics, roadway fundamentals propulsion system design - force velocity characteristics, calculation of tractive power and energy required, electric vehicle power source - battery capacity, state of charge and discharge, specific energy, specific power, Ragone plot. battery modeling - run time battery model, first principle model, battery management system- soc measurement, battery cell balancing. Traction batteries - nickel metal hydride battery, Li-Ion, Lipolymer battery.

Unit II

Electric Vehicle Power Plant And Drives

Introduction electric vehicle power plants. Induction machines, permanent magnet machines, switch reluctance machines. Power electronic converters-DC/DC converters - buck boost converter, isolated DC/DC converter. Two quadrant chopper and switching modes. AC drives- PWM, current control method. Switch reluctance machine drives - voltage control, current control.



Unit III

Hybrid And Electric Drive Trains

Introduction hybrid electric vehicles, history and social importance, impact of modern drive trains in energy supplies. Hybrid traction and electric traction. Hybrid and electric drive train topologies. Power flow control and energy efficiency analysis, configuration and control of DC motor drives and induction motor drives, permanent magnet motor drives, switch reluctance motor drives, drive system efficiency.

Unit IV

Electric and Hybrid Vehicles - Case Studies

Parallel hybrid, series hybrid -charge sustaining, charge depleting. Hybrid vehicle case study – Toyota Prius, Honda Insight, Chevrolet Volt. 42 V system for traction applications. Lightly hybridized vehicles and low voltage systems. Electric vehicle case study - GM EV1, Nissan Leaf, Mitsubishi Miev. Hybrid electric heavy-duty vehicles, fuel cell heavy duty vehicles.

Unit V

Electric And Hybrid Vehicle Design :

Introduction to hybrid vehicle design. Matching the electric machine and the internal combustion engine. Sizing of propulsion motor, power electronics, drive system. Selection of energy storage technology, communications, supporting subsystem. Energy management strategies in hybrid and electric vehicles - energy management strategies- classification, comparison, implementation.

Text Books:

1. Iqbal Hussein, —Electric and Hybrid Vehicles: Design Fundamentals, 2nd edition, CRC Press, 2003.
2. Amir Khajepour, M. Saber Fallah, Avesta Goodarzi, —Electric and Hybrid Vehicles: Technologies, Modeling and Control - A Mechatronic Approach, illustrated edition, John Wiley & Sons, 2014

Reference Books:

1. James Larminie, John Lowry, —Electric Vehicle Technology, Explained, Wiley, 2003.
2. John G. Hayes, G. Abas Goodarzi, —Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, 1st edition, Wiley- Blackwell, 2018.
3. Mehrdad Ehsani, YimiGao, Sebastian E. Gay, Ali Emadi, —Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
Introduction to hybrid and electric vehicles	CO1	3	3	-	2	-	-	-	-	-	-	-	3	2	
	CO2	3	3	3	-	3	-	-	-	-	-	-	3	3	
	CO3	3	3	-	2	-	-	-	-	-	-	-	3	2	
	CO4	-	3	2	3	2	-	-	-	-	-	-	3	3	
	CO5	3	3	3	-	3	-	-	-	-	-	-	3	3	

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours (%)			CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1				Analyze	L4	PO1, PO2, PO4	Apply(L3), Analyze(L4), Analyze(L4)	3
2				Design	L6	PO1	Apply(L3)	3



						PO2, PO3, PO5	Analyze(L4), Design(L6), Usage(L3)	
3				Analyze	L4	PO1, PO2, PO4	Apply(L3), Analyze(L4), Analyze(L4)	3
4				Evaluate	L5	PO2, PO3, PO4, PO5	Analyze(L4), Design(L6), Analyze(L4) Usage(L3)	3
5				Design	L6	PO1, PO2, PO3, PO5	Apply(L3), Analyze(L4), Design(L6), Usage(L3)	3

Justification Statements:

- **CO1:** Analyze electric vehicle propulsion systems and evaluate the performance of various energy storage technologies.

Action Verbs: Analyze (L4) / Evaluate (L5)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4)

Justification: The CO1 Action Verbs 'Analyze' (L4) and 'Evaluate' (L5) are at a higher cognitive level than PO1's 'Apply' (L3) and are equal to or higher than PO2's and PO4's 'Analyze' (L4). This outcome requires analyzing complex engineering problems and making substantiated judgments. Therefore, the correlation is high (3).

- **CO2:** Design and analyze power electronic converters and their control strategies for electric vehicle drives.

Action Verbs: Design (L6) / Analyze (L4)

PO2, PO3 & PO5 Verbs: Analyze (L4), Design (L6), Usage (L3)

Justification: The CO2 Action Verb 'Design' (L6) is at the same level as PO3's verb, while 'Analyze' (L4) matches PO2. The design process inherently requires analysis and the use of modern tools (PO5). Therefore, the correlation is high (3).

- **CO3:** Analyze and compare the architectures and power flow control of various hybrid and electric drivetrain topologies.

Action Verbs: Analyze (L4) / Compare (L4)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4)

Justification: The CO3 Action Verb 'Analyze' (L4) is at a higher cognitive level than PO1's 'Apply' (L3) and is equal to the verbs for PO2 and PO4. This outcome involves a detailed examination and comparison of complex systems. Therefore, the correlation is high (3).

- **CO4:** Evaluate the system integration and control strategies of commercial hybrid and electric vehicles through case studies.

Action Verb: Evaluate (L5)

PO2, PO3 & PO4 Verbs: Analyze (L4), Design (L6)

Justification: The CO4 Action Verb 'Evaluate' (L5) is a higher-order skill that requires deep analysis (PO2, PO4) to make judgments about existing designs, a key aspect of informing new designs (PO3). Therefore, the correlation is high (3).

- **CO5:** Design key components of a hybrid vehicle powertrain and develop appropriate energy management strategies.



Action Verbs: Design (L6) / Develop (L6)

PO2, PO3 & PO5 Verbs: Analyze (L4), Design (L6), Usage (L3)

Justification: The CO5 Action Verbs 'Design' and 'Develop' (L6) are at the same cognitive level as PO3's 'Design' (L6). This complex task requires in-depth analysis (PO2), the use of modern engineering tools (PO5), and consideration for societal and environmental impact (PO6, PO7). Therefore, the correlation is high (3)



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0319	Heat Transfer Lab	0	0	3	1.5

Course Outcomes:

- CO: 1 Determine the thermal conductivity of solids and insulating materials through conduction experiments.
- CO: 2 Analyze convective heat transfer coefficients for vertical cylinders and internal flows under natural and forced convection.
- CO: 3 Evaluate the performance of extended surfaces (fins) and heat exchangers.
- CO: 4 Analyze heat transfer phenomena during phase change processes, including pool boiling and condensation.
- CO: 5 Determine the emissivity and Stefan-Boltzmann constant through radiation experiments

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Determine	The thermal conductivity of solids and insulating materials.	through conduction experiments.		L5
CO2	Analyze	Convective heat transfer coefficients for vertical cylinders and internal flows.	under natural and forced convection.		L4
CO3	Evaluate	The performance of extended surfaces (fins) and heat exchangers.			L5
CO4	Analyze	Heat transfer phenomena during phase change processes.	including pool boiling and condensation.		L4
CO5	Determine	The emissivity and Stefan-Boltzmann constant.	through radiation experiments.		L5

List of Experiments:

1. Determine the overall heat transfer coefficient across the width of composite wall
2. Determine the thermal conductivity of a metal rod
3. Determine the thermal conductivity of insulating powder material through concentric sphere apparatus
4. Determine the thermal conductivity of insulating material through lagged pipe apparatus
5. Determine the efficiency of a pin fin in natural and forced convection.
6. Determine the heat transfer coefficient for a vertical cylinder in natural convection
7. Determine the heat transfer coefficient in forced convection of air in a horizontal tube.
8. Determine the heat transfer coefficients on film and drop wise condensation apparatus.
9. Determine the effectiveness of a parallel and counter flow heat exchanger.
10. Study the pool boiling phenomenon and different regimes of pool boiling.
11. Experiment on pool boiling
12. Determine the emissivity of the test plate surface.
13. Experiment on Stefan-Boltzmann apparatus
14. Determine the heat transfer rate coefficient in fluidized bed apparatus.



Virtual Lab:-

1. Determination of thermal conductivity of a metal rod
<https://sites.google.com/view/vlab-bnmitmech/home/heat-transfer-lab/determination-of-thermal-conductivity-of-a-metal-rod>
2. Natural Convection heat transfer
<https://sites.google.com/view/vlab-bnmitmech/home/heat-transfer-lab/natural-convection>
3. Heat Transfer by Radiation
<https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=802&cnt=1>
4. Heat transfer by Conduction
<https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=801&cnt=1>
5. The Study of phase change
<https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=709&cnt=1>
6. Black Body Radiation: Determination of Stefan's Constant
<https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=548&cnt=1>
7. Newton's Law of Cooling
<https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=354&cnt=1>
8. Lee's Disc Apparatus
<https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=353&cnt=1>
9. Thermo Couple-Seebeck Effect
<https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=351&cnt=1>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Heat Transfer lab	CO1	3	3		3								3	2
	CO2	3	3		3								3	2
	CO3	3	3		3								3	3
	CO4	3	3		3								3	2
	CO5	3	3		3								3	2

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1	9	25	3	Determine	L5	PO1, PO2, PO4	Apply(L3) Analyze(L4) Analyze(L4)	3
2	6	16	2	Analyze	L4	PO1, PO2, PO4	Apply(L3) Analyze(L4) Analyze(L4)	3
3	9	25	3	Evaluate	L5	PO2, PO3, PO4	Analyze(L4), Design(L6), Analyze(L4)	3



4	6	16	2	Analyze	L4	PO1, PO2, PO4	Apply(L3), Analyze(L4), Analyze(L4)	3
5	6	16	2	Determine	L5	PO1, PO2, PO4	Apply(L3), Analyze(L4), Analyze(L4)	3
Total	36							

Justification Statements:

- **CO1:** Determine the thermal conductivity of solids and insulating materials through conduction experiments.

Action Verb: Determine (L5, a form of Evaluation)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4)

The CO1 Action Verb 'Determine' (Evaluate - L5) is a higher-order skill that requires applying fundamental principles (PO1) and conducting investigations (PO4) to analyze experimental data (PO2). Therefore, the correlation is high (3).

- **CO2:** Analyze convective heat transfer coefficients for vertical cylinders and internal flows under natural and forced convection.

Action Verb: Analyze (L4)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4)

The CO2 Action Verb 'Analyze' (L4) is at a higher cognitive level than PO1's 'Apply' (L3) and is equal to the verbs for PO2 and PO4. This outcome involves analyzing experimental data from investigations of complex phenomena. Therefore, the correlation is high (3).

- **CO3:** Evaluate the performance of extended surfaces (fins) and heat exchangers.

Action Verb: Evaluate (L5)

PO2, PO3 & PO4 Verbs: Analyze (L4), Design (L6)

The CO3 Action Verb 'Evaluate' (L5) is a higher-order skill that requires analysis of experimental data (PO2, PO4) and is a critical component of designing thermal systems (PO3). The ability to make judgments on performance is fundamental. Therefore, the correlation is high (3).

- **CO4:** Analyze heat transfer phenomena during phase change processes, including pool boiling and condensation.

Action Verb: Analyze (L4)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4)

The CO4 Action Verb 'Analyze' (L4) is at a higher level than PO1's 'Apply' (L3) and is equal to the verbs for PO2 and PO4. It requires conducting investigations and analyzing complex phase change behavior. Therefore, the correlation is high (3).

- **CO5:** Determine the emissivity and Stefan-Boltzmann constant through radiation experiments.

Action Verb: Determine (L5, a form of Evaluation)



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

PO1, PO2 & PO4 Verbs: Apply (L3), Analyze (L4)

The CO5 Action Verb 'Determine' (Evaluate - L5) is a higher-order skill that requires applying fundamental laws of radiation (PO1) and conducting experiments (PO4) to analyze data and draw conclusions (PO2). Therefore, the correlation is high (3).



Year: III

Semester: II

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0320	CAD/CAM Lab	0	0	3	1.5

Course Outcomes:

- CO: 1 Create accurate 2D technical drawings using orthographic and isometric projections, and interpret file formats like DXE and IGES.
- CO: 2 Develop 3D part models using features such as protrude, revolve, shell, and sweep, and demonstrate and evaluate parent-child relationships.
- CO: 3 Construct and analyze assemblies using feature-based and Boolean operations for simple mechanical systems and create complex mechanical assemblies.
- CO: 4 Generate NC code for complex surfaces using CAM tools and study the function of various post-processors.
- CO: 5 Transfer NC code to CNC machines. Perform and evaluate basic machining tasks such as turning and milling and generate new technics by using modern tools.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Create	accurate 2D technical drawings using orthographic and isometric projections, and interpret file formats like DXE and IGES.			L4
CO2	Develop	3D part models using features such as protrude, revolve, shell, and sweep, and demonstrate and evaluate parent-child relationships.			L3
CO3	Construct	and analyze assemblies using feature-based and Boolean operations for simple mechanical systems and create complex mechanical assemblies.			L3
CO4	Create	NC code for complex surfaces using CAM tools and study the function of various post-processors.			L5
CO5	Develop	NC code to CNC machines. Perform and evaluate basic machining tasks such as turning and milling and generate new technics by using modern tools.			L5

List of Experiments:

1. **Drafting:** Development of part drawings for various components in the form of orthographic and isometric. Representation of Dimensioning and tolerances scanning and plotting. Study of script, DXE AND IGES FILES.
2. **Part Modelling:** Generation of various 3D Models through Protrusion, revolve, shell sweep. Creation of various features. Study of parent child relation.
3. **Assembly modelling:** Feature based and Boolean based modelling surfaces, Assembly Modelling of simple components and Design of simple components.
4. **CAM:**
 - Study of various post processors used in NC Machines.
 - Development of NC code for free form and sculptured surfaces using CAM packages.
 - Machining of simple components on NC lathe and Mill by transferring NC Code / from a CAM packages.

Through Any Four Software Packages from the following: Use of Auto CAD, Micro Station, CATIA, Pro-E, I-DEAS, , CAEFEM, Gibbs CAM, Master CAM etc.,

5. Evaluation of Stress/Strain for a plate with a hole.



Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CAD/CAM Lab	CO1	3	3	3						3			3	3
	CO2	3	3	3						3			3	3
	CO3	3	3	3						3			3	3
	CO4	3	3	3						3			3	3
	CO5	3	3	3						3			3	3

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				Analyze	L4	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
2				Apply	L3	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
3				Apply	L3	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
4				Evaluate	L5	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
5				Evaluate	L5	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
Total								

Justification Statements:

CO1: Analyze knowledge about the parts of various machine tools and about different shapes of products that can be produced on them.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO1 co-relates highly with PO9. Therefore, the correlation is high (3)

CO2: Apply the slotting operations to produce internal and external slots on the component.

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)



PO3 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

CO3: **Apply** the milling operations to produce groove and gear cutting on the specimen

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO3 co-relates highly with PO9. Therefore, the correlation is high (3)

CO4: **Evaluate** bores, angles and tapers

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO4 co-relates highly with PO9. Therefore, the correlation is high (3)

CO5: **Evaluate** alignment tests on various machines.

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO5 co-relates highly with PO9. Therefore, the correlation is high (3).



Subject Code	Subject Name	L	T/CLC	P	Credits
23ASC0302	3D Printing Lab	0	1	2	2

Course Outcomes:

- CO: 1 Analyze the effect of slicing parameters (layer thickness, orientation, infill) on the build time and G-code generation for a given 3D model.
- CO: 2 Evaluate the quality and dimensional accuracy of 3D printed components by systematically varying process parameters and materials.
- CO: 3 Apply reverse engineering principles to create a digital model from a physical object using a 3D scanner.
- CO: 4 Analyze and identify common defects in 3D printed parts and relate them to specific process parameters or material properties.
- CO: 5 Create a physical prototype by executing the complete additive manufacturing workflow, from CAD modeling to final part fabrication and inspection

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	The effect of slicing parameters (layer thickness, orientation, infill).	on the build time and G-code generation for a given 3D model.		L4
CO2	Evaluate	The quality and dimensional accuracy of 3D printed components.	by systematically varying process parameters and materials.		L5
CO3	Apply	Reverse engineering principles.	to create a digital model from a physical object using a 3D scanner.		L3
CO4	Analyze	And identify common defects in 3D printed parts.	and relate them to specific process parameters or material properties.		L4
CO5	Create	A physical prototype.	by executing the complete additive manufacturing workflow, from CAD modeling to final part fabrication and inspection.		L6

Module 1:

Introduction to Prototyping, Working of 3D Printer, Types of 3D printing Machines:

Exp 1: Modelling of Engineering component and conversion of STL format.

Exp 2: Slicing of STL file and study of effect of process parameter like layer thickness, orientation, and infill on build time using software.

Exercise 1 : Component-1

Exercise 2 : Component-2

Module 2:

Exp 1 : 3D Printing of modelled component by varying layer thickness.

Exp 2 : 3D Printing of modelled component by varying orientation.



Exp 3: 3D Printing of modelled component by varying infill.

Module 3:

Study on effect of different materials like ABS, PLA, Resin etc, and dimensional accuracy.

Module 4:

Identifying the defects in 3D Printed components.

Module 5

Exp1: Modelling of component using 3D Scanner of real life object of unknown dimension in reverse engineering.

Exp 2: 3D Printing of above modelled component.

References:

1. Ian Gibson, David W. Rosen, Brent Stucker, Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 1/e, Springer, 2010.
2. Chua C.K., Leong K.F. and Lim C.S., Rapid Prototyping: Principles and Applications, 2/e, World Scientific Publishers, 2003.

Online Learning Resources/Virtual Labs:

- <https://www.hubs.com/knowledge-base/introduction-fdm-3d-printing/>
 - <https://slideplayer.com/slide/6927137/>
 - <https://www.mdpi.com/2073-4360/12/6/1334>
 - <https://www.centropiaggio.unipi.it/sites/default/files/course/material/2013-11-29%20-%20FDM.pdf>
 - <https://lecturenotes.in/subject/197>
 - https://www.cet.edu.in/noticefiles/258_Lecture%20Notes%20on%20RP-ilovepdf-compressed.pdf
 - https://www.vssut.ac.in/lecture_notes/lecture1517967201.pdf
- <https://www.youtube.com/watch?v=NkC8TNts4B4>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
3D Printing Lab	CO1	3	3	3						3			3	3
	CO2	3	3	3						3			3	3
	CO3	3	3	3						3			3	3
	CO4	3	3	3						3			3	3
	CO5	3	3	3						3			3	3

Correlation matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	correlation	Verb	BTL			
1				Analyze	L4	PO1 PO2 PO3 PO9	Apply (L3) Identify (L2) Develop (L3) Thumb Rule	3 3 3 3
2				Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L2) Develop (L3)	3 3 3



Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

						PO9	Thumb Rule	3
3				Apply	L3	PO1	Apply (L3)	3
						PO2	Identify (L2)	3
						PO3	Develop (L3)	3
						PO9	Thumb Rule	3
4				Evaluate	L5	PO1	Apply (L3)	3
						PO2	Identify (L2)	3
						PO3	Develop (L3)	3
						PO9	Thumb Rule	3
5				Evaluate	L5	PO1	Apply (L3)	3
						PO2	Identify (L2)	3
						PO3	Develop (L3)	3
						PO9	Thumb Rule	3
Total								

Justification Statements:

CO1: Analyze knowledge about the parts of various machine tools and about different shapes of products that can be produced on them.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO1 co-relates highly with PO9. Therefore, the correlation is high (3)

CO2: Apply the slotting operations to produce internal and external slots on the component.

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO2 co-relates highly with PO9. Therefore, the correlation is high (3)

CO3: Apply the milling operations to produce groove and gear cutting on the specimen

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO3 co-relates highly with PO9. Therefore, the correlation is high (3)

CO4: Evaluate bores, angles and tapers

Action Verb: Apply (L3)



PO1Verb: **Apply (L3)**

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO4 co-relates highly with PO9. Therefore, the correlation is high (3)

CO5: **Evaluate** alignment tests on various machines.

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L2)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO9 Verb: Thumb Rule

CO5 co-relates highly with PO9. Therefore, the correlation is high (3).



Year: III

Semester: II

Branch of Study: Common to all

Subject Code	Subject Name	L	T/CLC	P	Credits
23AMC9902	Technical Paper Writing And Intellectual Property Rights	2	0	0	-

Course Outcomes (CO): Student will be able to

CO1	Understand various principles and styles of technical writing by avoiding confusion, repetition, unclear language and plagiarism.	L2
CO2	Apply the fundamentals of technical research paper writing by organizing abstract, objectives, limitations, literature review to frame effective research questions.	L3
CO3	Apply the research process and publication mechanisms and follow citation rules and proofreading techniques for paper writing.	L3
CO4	Evaluate the rights and responsibilities of the holder of Intellectual Property.	L5
CO5	Apply various forms of copy rights and patents at national and international levels.	L3

CO	Action Verb	Knowledge Statement		Criteria	Blooms level
1	Understand	various principles and styles of technical writing by avoiding confusion, repetition, unclear language and plagiarism.			L2
2	Apply	the fundamentals of technical research paper writing by organizing abstract, objectives, limitations, literature review to frame effective research questions.	by organizing abstract, objectives, limitations, literature review to frame effective research questions.		L3
3	Apply	the research process and publication mechanisms and follow citation rules and proofreading techniques for paper writing.		for paper writing.	L3
4	Evaluate	rights and responsibilities of holder of Patent, Copyright, trademark, International Trademark etc.			L5
5	Apply	various forms of copy rights and patents at national and international levels		At national and international levels	L3



UNIT :1

Principles of Technical Writing: styles in technical writing; clarity, precision, coherence and logical sequence in writing-avoiding ambiguity- repetition, and vague language -highlighting your findings- discussing your limitations -hedging and criticizing -plagiarism and paraphrasing.

UNIT – II:

Technical Research Paper Writing: Abstract- Objectives-Limitations Review of Literature- Problems and Framing Research Questions- Synopsis

UNIT – III:

Process of research: publication mechanism: types of journals- indexing-seminars- conferences- proof reading –plagiarism style; seminar & conference paper writing; Methodology-discussion-results- citation rules

UNIT – IV:

Introduction to Intellectual property: Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights

Trade Marks: Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting technical evaluating trade mark, trade mark registration processes.

UNIT – V:

Law of copy rights: Fundamentals of copy right law, originality of material, rights of reproduction, rights to perform the work publicly, copy right ownership issues, copy right registration, notice of copy right, international copy right law

Law of patents: Foundation of patent law, patent searching process, ownership rights and transfer, Patent law, intellectual property audits.

Textbooks:

1. Deborah. E. Bouchoux, *Intellectual Property Rights*, Cengage Learning India, 2013
2. Meenakshi Raman, Sangeeta Sharma. *Technical Communication: Principles and practices*. Oxford.

Reference Books:

1. R.Myneni, *Law of Intellectual Property*, 9th Ed, Asia law House, 2019.
2. Prabuddha Ganguli, *Intellectual Property Rights* Tata Mcgraw Hill, 2001
3. P.Naryan, *Intellectual Property Law*, 3rd Ed, Eastern Law House, 2007.
4. Adrian Wallwork. *English for Writing Research Papers* Second Edition. Springer Cham Heidelberg New York ,2016
5. Dan Jones, Sam Dragga, *Technical Writing Style*

Online Resources

1. <https://theconceptwriters.com.pk/principles-of-technical-writing/>
2. <https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/TechPaperWriting.html>
3. <https://www.ewh.ieee.org/soc/emcs/acstrial/newsletters/summer10/TechPaperWriting.html>
4. <https://www.manuscriptedit.com/scholar-hangout/process-publishing-research-paper-journal/>
5. <https://www.icsi.edu/media/website/IntellectualPropertyRightLaws&Practice.pdf>
6. <https://lawbhoomi.com/intellectual-property-rights-notes/>
7. <https://www.extension.purdue.edu/extmedia/ec/ec-723.pdf>



Correlation of COs with the POs & PSOs for B.Tech

AK-23 Regulations

***3: Highly Correlated, 2: Moderately Correlated, 1: Weakly Correlated**

Course Title	Course Outcomes COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11
TECHNICAL PAPER WRITING AND INTELLECTUAL PROPER RIGHTS (Audit Course)	CO1									2		
	CO2		3									
	CO3									2		2
	CO4											3
	CO5											2

CO-PO mapping justification:

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcome (PO)	PO(s): Action verb and BTL (for PO1 to PO5)	Level of Correlation (0-3)
	Lesson Plan (Hrs)	%	cor r	Verb	BT L			
1							Thumb Rule	2
2							Analyze	3
3							Thumb Rule	2
4							Thumb Rule	3
5							Thumb Rule	2

CO1: Understand various principles and styles of technical writing by avoiding confusion, repetition, unclear language and plagiarism.

Action Verb: Understand (L2)

CO1 Action Verb Understand is of BTL 2. Using Thumb rule, L2 correlates PO6 to PO11 as moderate (2).

CO2: Apply the fundamentals of technical research paper writing by organizing abstract, objectives, limitations, literature review to frame effective research questions.

Action Verb: Apply (L3)

CO2 Action Verb Apply is of BTL 3. L3 is equal to PO2, then correlation is high (3)

CO3: Apply the research process and publication mechanisms and follow citation rules and proofreading techniques for paper writing.

Action Verb: Apply (L3)

CO3 Action Verb Apply is of BTL 3. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2)

CO4: Evaluate the rights and responsibilities of the holder of Intellectual Property.

Action Verb: Evaluate (L5)

CO4 Action Verb Analyze is of BTL 4. Using Thumb rule, L5 correlates PO6 to PO11 as high (3).

CO5: Apply various forms of copy rights and patents at national and international levels.

Action Verb: Apply (L3)

CO5 Action Verb Analyse is of BTL 4. Using Thumb rule, L3 correlates PO6 to PO11 as moderate (2).



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MECHANICAL ENGINEERING (ME)

AK23 Regulations

B. Tech – IV Year I Semester

Sl. No.	Category	Course Code	Course Title	Hours per week			Credits	CIE	SEE	Total
				L	T/C LC	P				
1	PC	23APC0321	AI & ML for Mechanical Engineering	2	1	0	3	30	70	100
2	HM	23AHMMB04	Business Ethics and Corporate Governance	2	0	0	2	30	70	100
		23AHMMB05	E-Business							
		23AHMMB06	Management Science							
3	PE-IV	23APE0316	Mechanical Vibrations	2	1	0	3	30	70	100
		23APE0317	Finite Element Methods							
		23APE0318	Refrigeration & Air Conditioning							
		23APE0319	Mechatronics & MEMS							
		23APE0320	Power Plant Engineering							
4	PE-V	23APE0321	Non-Conventional Energy Sources	2	1	0	3	30	70	100
		23APE0322	Automation & Robotics							
		23APE0323	Non-Destructive Testing							
		23APE0324	Total Quality Management							
		23APE0325	Smart Manufacturing							
5	OE-III		Open Elective-III	2	1	0	3	30	70	100
6	OE-IV		Open Elective-IV	2	1	0	3	25	75	100
7	SC	23ASC0406	Skill Enhancement Course Introduction to Drone Technology	0	1	2	2	30	70	100
8	MC	23AMCMB01	Gender Sensitization	2	0	0	-	30	-	30
9	PR	23APR0302	Evaluation of Industry Internship (Short Term)	-	-	-	2	100	-	100
Total				14	6	2	21	330	500	830

Open Elective – III

S.No.	Course Code	Course Name	Offered by the Dept.
1	23AOE0105	Building Materials and Services	CIVIL
2	23APE0103	Environmental Impact Assessment	
3	23AOE0203	Smart Grid Technologies	EEE
4	23APC0412	Microprocessors and Microcontrollers	ECE
5	23AOE0506	Data Base Management Systems	CSE & Allied/IT
6	23AOE0507	Cyber Security	
7	23AOE9904	Wavelet transforms and its applications	Mathematics
8	23AOE9908	Smart Materials and Devices	Physics
9	23AOE9909	Introduction to Quantum Mechanics	
10	23AOE9913	Green Chemistry and Catalysis for Sustainable Environment	Chemistry
11	23AOE9917	Employability Skills	Humanities



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AK23 Regulations

Open Elective – IV

S.No.	Course Code	Course Name	Offered by the Dept.
1	23AOE0106	Geo-Spatial Technologies	CIVIL
2	23AOE0107	Solid Waste Management	
3	23AOE0204	Electric Vehicles	EEE
4	23AOE0403	Transducers and Sensors	ECE
5	23AOE0508	Computer Networks	CSE & Allied/IT
6	23AOE0509	Internet of Things	
7	23AOE0510	Quantum Computing	
8	23AOE9905	Financial Mathematics	Mathematics
9	23AOE9910	Sensors and Actuators for Engineering Applications	Physics
10	23AOE9914	Chemistry of Nanomaterials and Applications	Chemistry
11	23AOE9918	Literary Vibes	Humanities



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MECHANICAL ENGINEERING (ME)

AK23 Regulations

Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APC0321	AI & ML for Mechanical Engineering	2	1	0	3

Course Outcomes:

- CO: 1 Analyze intelligent problem-solving agents by mapping them to appropriate state-space search environments.
- CO: 2 Evaluate and implement uniform, heuristic and local optimization search strategies for complex state spaces.
- CO: 3 Analyze optimal decision-making strategies in adversarial games and constraint satisfaction problems.
- CO: 4 Apply robust knowledge-representation structures and inferential reasoning models under uncertainty.
- CO: 5 Analyze machine learning paradigms and deploy fundamental frameworks for structural data tasks.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	intelligent problem-solving agents by mapping them to appropriate state-space search environments			L4
CO2	Evaluate	implement uniform, heuristic, and local optimization search strategies for complex state spaces.			L5
CO3	Analyze	optimal decision-making strategies in adversarial games and constraint satisfaction problems.			L4
CO4	Apply	robust knowledge-representation structures and inferential reasoning models under uncertainty			L3
CO5	Analyze	machine learning paradigms and deploy fundamental frameworks for structural data tasks			L4

Unit I:

Introduction to Artificial Intelligence and Problem-Solving Agent: Problems of AI, AI technique, Tic – Tac – Toe problem. Intelligent Agents, Agents & environment, nature of environment, structure of agents, goal-based agents, utility-based agents, learning agents. Defining the problem as state space search, production system, problem characteristics and issues in the design of search programs.

Unit II

Search Techniques: Problem solving agents, searching for solutions; uniform search strategies: breadth first search, depth first search, depth limited search, bidirectional search, comparing uniform search strategies. Heuristic search strategies Greedy best-first search, A* search, AO* search, memory bounded heuristic search: local search algorithms & optimization problems: Hill climbing search, simulated annealing search, local beam search.

Unit III

Constraint Satisfaction Problems and Game Theory: Local search for constraint satisfaction problems. Adversarial search, Games, optimal decisions & strategies in games, the minimax search procedure, alpha-beta pruning, additional refinements, iterative deepening.



Unit IV

Knowledge & Reasoning: Statistical Reasoning: Probability and Bays Theorem, Certainty Factors and Rule-Based Systems, Bayesian Networks, Dempster Shafer Theory, Fuzzy Logic. AI for knowledge representation, rule based knowledge representation, procedural and declarative knowledge, Logic programming, Forward and backward reasoning.

Unit V

Introduction to Machine Learning: Exploring sub-discipline of AI: Machine Learning, Supervised learning, Unsupervised learning, Reinforcement learning, Classification problems, Regression problems, Clustering problems, Introduction to neural networks and deep learning.

TextBooks

1. S.Russell and P.Norvig, –Artificial Intelligence: A Modern Approach, Prentice Hall, Third Edition, 2015.
2. Nils J. Nilsson, –Artificial Intelligence: A New Synthesis, 1st Edition, Morgan-Kaufmann, 1998.

ReferenceBooks

1. Elaine Rich, Kevin Knight, & Shiva shankar B Nair, –Artificial Intelligence, McGraw Hill, 3rd ed., 2017.
2. Patterson, –Introduction to Artificial Intelligence & Expert Systems, Pearson, 1st ed. 2015.
3. Saroj Kaushik, –Logic & Prolog Programming, New Age International, 1st edition, 2002.
4. Joseph C. Giarratano, Gary D. Riley, –Expert Systems: Principles and Programming, 4th Edition, 2007.

Online Learning Resources:

- <https://nptel.ac.in/courses/113104517>
- <https://nptel.ac.in/courses/127104664>
- <https://nptel.ac.in/courses/110104164>
- <https://nptel.ac.in/courses/106106226>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
AI & ML for Mechanical Engineering	CO1	3	3											
	CO2	3	3											
	CO3	3	3											
	CO4	3	3											
	CO5	3	3											

Correlation Matrix

CO				CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	14	23.33	3	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
2	12	20	2	Evaluate	L5	PO1 PO2	Apply (L3) Identify (L3)	3 3
3	11	18.33	2	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	12	20	2	Apply	L3	PO1 PO2	Apply (L3) Identify (L3)	3 3
5	11	18.33	2	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3



Justification Statements:

CO1: Analyze intelligent problem-solving agents by mapping them to appropriate state-space search environments.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb: **Identify (L3)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO2: Evaluate and implement uniform, heuristic and local optimization search strategies for complex state spaces.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb: **Identify (L3)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO3: Analyze optimal decision-making strategies in adversarial games and constraint satisfaction problems.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb: **Identify (L3)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO4: Apply robust knowledge-representation structures and inferential reasoning models under uncertainty.

Action Verb: Apply (L3)

PO1Verb: **Apply (L3)**

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2Verb: **Identify (L3)**

CO4 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO5: Analyze machine learning paradigms and deploy fundamental frameworks for structural data tasks.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb: **Identify (L3)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)



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MECHANICAL ENGINEERING (ME)

AK23 Regulations

Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23AHMMB06	MANAGEMENT SCIENCE	2	0	0	2

Course Outcomes:

CO1: Understand the concepts of management and organizational structures to interpret managerial practices in organizations.

CO2: Analyze how to manage the stock efficiently in the organization by using inventory control techniques like EOQ, ABC analysis.

Understand various marketing concepts to market the products of an organization in the competitive market.

CO3: Apply various functions of human resource management effectively to manage the employees of an organization.

CO4: Apply the concepts of strategic management and environmental scanning to form company strategies. Evaluate PERT and CPM techniques for project management.

CO5: Analyze modern management practices to improve organizational performance and sustainability.

CO	Action Verb	Knowledge Statement	Condition	Criteria	BL
CO1	Understand	the concepts of management and organizational structures	to interpret managerial practices in organizations.		L2
CO2	Analyze	how to manage the stock efficiently in the organization	by using inventory control techniques like EOQ, ABC analysis.		L4
	Understand	various marketing concepts	to market the products of an organization in the competitive market		L2
CO3	Apply	various functions of human resource management effectively	to manage the employees of an organization.		L3
CO4	Apply	the concepts of strategic management and environmental scanning	to form company strategies.		L3
	Evaluate	PERT and CPM techniques for project management.			L5
CO5	Analyze	modern management practices	to improve organizational performance and sustainability.		L4

Syllabus Units

UNIT - I INTRODUCTION TO MANAGEMENT

Management - Concept and meaning - Nature-Functions – Management as a Science and Art and both. Schools of Management Thought - Taylor's Scientific Theory–Henry Fayol's principles - Elton Mayo's Human relations - Organizational Designs - Line organization – Line & Staff Organization - Functional Organization - Matrix Organization - Project Organization – Committee form of Organization - Social responsibilities of Management.

UNIT - II OPERATIONS MANAGEMENT

Principles and Types of Plant Layout - Methods of Production (Job, batch and Mass Production), Work Study - Statistical Quality Control- Material Management - Objectives - Inventory-Functions - Types, Inventory Techniques - EOQ-ABC Analysis - Marketing Management - Concept - Meaning - Nature-Functions of Marketing - Marketing Mix - Channels of Distribution - Advertisement and Sales Promotion - Marketing Strategies based on Product Life Cycle.



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UNIT - III HUMAN RESOURCES MANAGEMENT (HRM)

HRM - Definition and Meaning – Nature – Managerial and Operative functions - Job Analysis - Human Resource Planning(HRP) – Employee Recruitment–Sources of Recruitment - Employee Selection - Process – Employee Training and Development - methods - Performance Appraisal Concept – Methods of Performance Appraisal – Placement - Employee Induction - Wage and Salary Administration

UNIT - IV STRATEGIC & PROJECT MANAGEMENT

Definition& Meaning - Setting of Vision – Mission - Goals - Corporate Planning Process - Environmental Scanning – Steps in Strategy Formulation and Implementation - SWOT Analysis – Project Management - Network Analysis - Programme Evaluation and Review Technique (PERT) – Critical Path Method (CPM) Identifying Critical Path – Probability of Completing the project within given time - Project Cost- Analysis – Project Crashing (Simple problems).

UNIT - V CONTEMPORARY ISSUES IN MANAGEMENT

Customer Relations Management(CRM) - Total Quality Management (TQM) - Six Sigma Concept - Supply Chain Management(SCM) - Enterprise Resource Planning (ERP) - Performance Management – employee engagement and retention - Business Process Re-engineering and Bench Marking - Knowledge Management – change management –sustainability and corporate social responsibility.

Text Books:

1. Frederick S. Hillier, Mark S. Hillier. Introduction to Management Science, October 26, 2023
2. A.R Aryasri, Management Science, TMH, 2019

Reference Books:

1. Stoner, Freeman, Gilbert. Management, Pearson Education, New Delhi, 2019.
2. Koontz & Weihrich, Essentials of Management, 6/e, TMH, 2005.
3. Thomas N. Duening & John M. Ivancevich, Management Principles and Guidelines, Biztantra.
4. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
5. Samuel C. Certo, Modern Management, 9/e, PHI, 2005

Online Learning Resources:

<https://www.classcentral.com/course/youtube-principles-of-management-14-principles-of-management-great-learning-98686>
<https://www.youtube.com/watch?v=33f1X3iY54M>
<https://www.youtube.com/watch?v=U-nHVGNDmV8>

CO-PO Mapping Matrix

Course Title	COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Management science	CO1								2					
	CO2		3			2								
	CO3								2					
	CO4		2								3			
	CO5										3			



Correlation Matrix & Lesson Plan Details

Unit No.	Lesson Plan (Hrs)	% Correlation	CO's	Action Verb	BTL	Program Outcome (PO)	PO(s): Action Verb and BTL	Level of Correlation (0-3)
1	12	17%	CO1	Understand	L2	PO10	Thumb Rule	2
2	12	17%	CO2	Analyse Understand	L4 L2	PO5 PO10	Apply Thumb Rule	3 2
3	18	25%	CO3	Apply	L3	PO8	Thumb Rule	2
4	15	21%	CO4	Apply Evaluate	L3 L5	PO2 PO10	Analyse Thumb Rule	2 3
5	15	21%	CO5	Analyze	L4	PO10	Thumb Rule	3
total	72	100						

Justification Statements:

CO1: Understand the concepts of management and organizational structures to interpret managerial practices in organizations.

Action Verb: Understand (L2)

PO10: Thumb rule

As using thumb rule, L2 correlates with PO10, Therefore the correlation is medium (2)

CO2: Analyze how to manage the stock efficiently in the organization by using inventory control techniques like EOQ, ABC analysis.

Action Verb: Analyze (L4)

PO5: Apply (L3)

CO2 Action verb is more than PO5 verb by one level. Therefore the correlation is high (3)

Understand various marketing concepts to market the products of an organization in the competitive market.

Action Verb: Understand (L2)

PO10: Thumb rule

As using thumb rule, L2 correlates with PO10, Therefore the correlation is medium (2)

CO3: Apply various functions of human resource management effectively to manage the employees of an organization.

Action Verb: Apply (L3)

PO8: Thumb rule

As using thumb rule, L3 correlates with PO8, Therefore the correlation is medium (2)

CO4: Apply the concepts of strategic management and environmental scanning to form company strategies.

Action Verb: Apply (L3)

PO2: Analyse (L4)

CO4 Action verb is less than PO2 verb by one level. Therefore the correlation is medium (2)

Evaluate PERT and CPM techniques for project management.

Action Verb: Evaluate (L5)

PO10: Thumb rule

As using thumb rule, L5 correlates with PO10, Therefore the correlation is high (3)

CO5: Analyze modern management practices to improve organizational performance and sustainability.

Action Verb: Analyze (L4)

PO10: Thumb rule

As using thumb rule, L4 correlates with PO10, Therefore the correlation is high (3)



Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0316	Mechanical Vibrations	2	1	0	3

Course Outcomes:

- CO: 1 Apply the undamped and damped free vibrations in Single Degree Freedom systems using classical and energy methods.
- CO: 2 Analyze forced vibrations in Single Degree Freedom systems under various excitation forces.
- CO: 3 Analyze the equations of motion, natural frequencies, modes of vibration and their application in dynamic vibration absorbers.
- CO: 4 Apply Numerical and Analytical Methods to Multi-Degree of Freedom Systems.
- CO: 5 Analyze vibration measurement instruments and exciters for experimental testing.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Apply	undamped and damped free vibrations	In Single Degree Freedom using classical and energy methods.		L3
CO2	Analyze	Forced vibrations in Single Degree Freedom systems	under various Excitation forces.		L4
CO3	Analyze	equations of motion, natural frequencies, modes of vibration and their application		in dynamic vibration absorbers	L4
CO4	Apply	Numerical and Analytical Methods to Multi-Degree of Freedom Systems.		free and forced vibrations	L3
CO5	Analyze	vibration measurement instruments and exciters for experimental testing			L4

Unit I: Single Degree Freedom Systems Single Degree Freedom Systems: Un-damped free vibration: Classical method, Energy method, equivalent systems, torsional systems. Damped free vibration- Viscous damping, under damping, critical damping, over damping. Coulomb damping, equivalent damping coefficient. Simple problems. Whirling of shafts: Transverse vibrations: Dunkerley's lower bound approximation, Critical speed of shafts.

Unit II

Forced vibrations of Single Degree Freedom Systems Steady state forced vibration, sources of excitation, impressed harmonic force, resonance impressed force due to unbalance, motion excitation, transmissibility and isolation, performance of different type of isolators, power absorbed by viscous damping.

Unit III

Two Degree Freedom Systems: Formulation of Equation of motion, Natural frequencies and modes of vibration by classical method, coupled pendulum, forced vibration, dynamic vibration absorber.

Unit IV

Multi Degree Freedom Systems: Lagrangian method for formulation of equation of motion Influence co- efficient method, Lumped mass and distributed mass systems, Stodola method, Holzer's method, model analysis of free and forced vibrations.

Unit V

Vibration measurement and Applications Transducers: variable resistance transducers, Piezoelectric transducers, electro dynamic transducers and linear variable differential transformer transducer; Vibration pickups: vibrometer, accelerometer, velometer and phase distortion; Frequency-measuring instruments; Vibration exciters- Mechanical exciters and electro dynamic shaker.



Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

Text Books:

1. Singiresu S. Rao, Mechanical Vibrations, 6/e, Pearson Education, 2018.
2. G.K.Groover, Mechanical Vibrations, Nemchand& Bro, 8/e, 2009.

Reference Books:

1. L. Meirovich, Elements of Vibrations Analysis, Tata McGraw Hill, 1986.
2. S. Graham Kelly, Mechanical Vibrations, Tata McGraw Hill, 1996
3. William Thomson, Theory of Vibrations with Applications, 5/e, Pearson, 2008
4. William Weaver, Timeoshenko, and Young, Vibration Problems in Engineering, 5/e, John Wiley, 2013.
5. C. Nataraj, Vibration of Mechanical Systems, 1/e, Cenage Learning, 2012.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Mechanical Vibrations	CO1	3	3										2	2
	CO2	3	3	2									2	2
	CO3	3	3										2	2
	CO4	3											2	2
	CO5	3	3										2	2

Correlation Matrix

CO				CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	16	20	2	Apply	L3	PO1 PO2	Apply (L3) Identify (L3)	3 3
2	14	17	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Design (L6)	3 3 2
3	18	22	3	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	18	22	3	Apply	L3	PO1	Apply (L3)	3
5	16	20	2	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3

Justification Statements:

CO1:Apply the undamped and damped free vibrations in Single Degree Freedom systems using classical and energy methods.

ActionVerb:Apply(L3)

PO1Verb: **Apply (L3)**

CO1Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify (L3)**

CO1:Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO2:Analyze forced vibrations in Single Degree Freedom systems under various excitation forces.

ActionVerb:**Analyze(L4)**

PO1Verb:**Apply(L3)**

CO2:Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify (L3)**

CO2:Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3Verb:**Design (L6)**

CO2:Action verb is same level (lesser) as PO3 verb. Therefore, the correlation is medium (2)



CO3:Analyze the equations of motion, natural frequencies, modes of vibration, and their application in dynamic vibration absorbers.

Action Verb: **Analyze (L4)**

PO1 Verb: **Apply (L3)**

CO3: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO4: Apply Numerical and Analytical Methods to Multi-Degree of Freedom Systems.

Action Verb: **Apply (L3)**

PO1 Verb: **Apply (L3)**

CO4: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

CO5:Analyze vibration measurement instruments and exciters for experimental testing

Action Verb: **Analyze (L4)**

PO1 Verb: **Apply (L3)**

CO5: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)



Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0317	Finite Element Methods	2	1	0	3

Course Outcomes:

- CO: 1 Understand the concepts behind formulation methods in FEA
CO: 2 Analyze Structural Truss and Beam Elements Under Mechanical Loading.
CO: 3 Apply 2D finite element modeling to planar and axisymmetric components using Constant Strain Triangle elements.
CO: 4 Evaluate Isoparametric Formulations and Steady-State Thermal Fields.
CO: 5 Evaluate natural frequencies and mode shapes for structural and torsional dynamic configurations.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts behind formulation methods in FEA			L2
CO2	Analyze	Structural Truss and Beam Elements Under Mechanical Loading.			L4
CO3	Apply	2D finite element modeling to planar and axisymmetric components	using Constant Strain Triangle elements.		L3
CO4	Evaluate	Isoparametric Formulations and Steady-State Thermal Fields.			L5
CO5	Evaluate	natural frequencies and mode shapes for structural and torsional dynamic configurations.			L5

Unit I:

Introduction to finite element methods Introduction to finite element methods for solving field problems, applications, Stress and equilibrium, Boundary conditions, Strain-Displacement relations, Stress- strain relations for 2D and 3D Elastic problems. Potential energy and equilibrium, Rayleigh-Ritz method, Formulation of Finite Element Equations. One dimensional Problems: Finite element modelling of 1D bar elements coordinates and shape functions. Requirements for Convergence and Interpolation functions, Pascal's Triangle, Assembly of global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

Unit II

1D Analysis of Trusses and Beams Analysis of trusses: Stiffness Matrix for 1D truss element, Stress Calculations and Problems with maximum of three elements. Analysis of beams: Element Stiffness Matrix and Load vector for 1D beam element, Hermite shape functions and simple problems.

Unit III

2D Analysis Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions. Estimation of load Vector, Stresses. Finite element modeling of Axi-symmetric solids subjected to axi-symmetric loading with triangular elements.

Unit IV

Quadrilateral Elements & Thermal Analysis Quadrilateral Elements: Isoparametric, Sub parametric and Super parametric elements, Modelling of 4 noded and 8 noded quadrilateral elements and simple problems. Numerical Integration. Steady state heat transfer analysis: One dimensional analysis of composite slab and fin.

Unit V

Dynamic analysis Analysis of a 1D uniform shaft subjected to torsion – Simple problems Dynamic analysis:



Formulation of finite element model, element – mass matrices, evaluation of Eigen values and Eigen vectors for a bar and shaft.

Text Books:

1. T. Chandraputla, Ashok Belegundu, Introduction to Finite Element in Engineering, Pearson Publications, 4/e, 2011.
2. S.S.Rao, The Finite Element Methods in Engineering, Elsevier Butterworth -Heinemann, 2/e, 2011.
3. J N Reddy, An introduction to the Finite Element Method, McGraw – Hill, New York, 1993.

Reference Books:

1. R D Cook, D S Malkus and M E Plesha, Concepts and Applications of Finite Element Analysis, 3/e, John Wiley, New York, 1989.
2. K J Bathe, Finite Element Procedures in Engineering Analysis, Prentice-Hall, Englewood Cliffs, 1982.
3. G. Lakshmi Narasaiah, Finite Element Analysis, 1/e, B.S. Publications, 2008.
4. O C Zienkiewicz and R L Taylor, the Finite Element Method, 3/e. McGraw-Hill, 1989.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Finite Element Method	CO1	3	3	2		3							3	2
	CO2	3	3										3	2
	CO3	3	3										3	2
	CO4	3	3										3	2
	CO5	3	3										3	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18	23	3	Understand	L2	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Apply (L3)	2 2 2 2
2	15	19	2	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
3	15	19	2	Apply	L3	PO1 PO2	Apply (L3) Identify (L3)	3 3
4	15	19	2	Evaluate	L5	PO1 PO2	Apply (L3) Identify (L3)	3 3
5	16	21	3	Evaluate	L5	PO1 PO2	Apply (L3) Identify (L3)	3 3

Justification Statements:

CO1: Understand the concepts behind formulation methods in FEA

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same (less) level as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Identify (L3)**

CO1 Action verb is same (less) level as PO2 verb. Therefore, the correlation is medium (2)

PO3 Verb: **Develop (L6)**

CO1 Action verb is same (less) level as PO3 verb. Therefore, the correlation is medium (2)

PO5 Verb: **Apply (L3)**

CO1 Action verb is same (less) level as PO5 verb. Therefore, the correlation is medium (2)



CO2: Analyze Structural Truss and Beam Elements Under Mechanical Loading.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO2: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO3: Apply 2D finite element modeling to planar and axisymmetric components using Constant Strain Triangle elements.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO3: Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3: Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

CO4: Evaluate Isoparametric Formulations and Steady-State Thermal Fields.

Action Verb: **Evaluate (L5)**

PO1 Verb: **Apply (L3)**

CO4: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO5: Evaluate natural frequencies and mode shapes for structural and torsional dynamic configurations.

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO5: Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5: Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)



Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0318	Refrigeration & Air Conditioning	2	1	0	3

Course Outcomes:

- CO: 1 Analyze the principles of refrigeration and the performance of air refrigeration systems including aircraft applications.
- CO: 2 Apply thermodynamic principles and solve problems related to vapour compression refrigeration cycles using P-h and T-S diagrams.
- CO: 3 Analyze the operation of vapour absorption and Steam Jet Refrigeration Technologies.
- CO: 4 Evaluate air conditioning processes using psychometric charts.
- CO: 5 Analyze appropriate air conditioning equipment based on comfort requirements and system needs.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	the principles of refrigeration and the performance of air refrigeration systems including aircraft applications.			L4
CO2	Apply	thermodynamic principles and solve problems related to vapour compression refrigeration cycles using P-h and T-S diagrams			L3
CO3	Analyze	the operation of Vapour absorption and Steam Jet Refrigeration Technologies.			L4
CO4	Evaluate	air conditioning processes using psychometric charts.			L5
CO5	Analyze	appropriate air conditioning equipment based on comfort requirements and system needs.			L4

UNIT I

Introduction to Refrigeration

Necessity and Applications, Carnot Refrigerator, First and Second Law Applied to Refrigerating Machines, Unit of Refrigeration, COP, EER, Different Refrigeration Methods.

Air Refrigeration: Bell-Coleman Cycle, Ideal and Actual Cycles, Open and Dense Air Systems - Numerical Problems - Refrigeration Needs of Air Crafts.

UNIT II

Vapour Compression Refrigeration (VCR)

System Vapour Compression Refrigeration (VCR) System - Basic Cycle - Working Principle and Essential Components of the Plant - COP - Representation of Cycle On T-S and P-h Charts - Expander Vs. Throttling, Effect of Sub Cooling and Super Heating - Cycle Analysis - Actual Cycle- Influence of Various Parameters on System Performance - Construction and Use of P-h Charts - Numerical Problems. Refrigerants - Desirable Properties - Classification of Refrigerants Used - Nomenclature- Secondary Refrigerants- Lubricants - Ozone Depletion - Global Warming- Newer Refrigerants.

UNIT III

Vapor Absorption Refrigeration (VAR) System

Vapor Absorption Refrigeration (VAR) System-Description and Working of NH₃ - Water System and Li Br -Water (Two Shell & Four Shell) System -Calculation of Max COP, Principle of Operation of Three Fluid Absorption System

Steam Jet Refrigeration System: Working Principle and Basic Components-Estimation of Motive Steam Required Principle and Operation of: (I) Thermo-Electric Refrigerator (ii) Vortex Tube or Hilsch Tube.

UNIT IV



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

Course structure for Four Year Regular B.Tech. Degree Program

(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

AK23 Regulations

Introduction to Air Conditioning: Psychrometric Properties & Processes - Characterization of Sensible and Latent Heat Loads - Need For Ventilation, Consideration of Infiltrated Air - Heat Load Concepts. Air Cooler (Evaporative Cooling), Window, Split, Summer, Winter, Year Round, Central Air Conditioning Systems.

UNIT V

Air Conditioning Equipment

Air Conditioning Equipment - Humidifiers - Dehumidifiers - Air Filters, Fans and Blowers. Human Comfort: Requirements of Temperature, Humidity And Concept of Effective Temperature, Comfort Chart. Heat Pump - Heat Sources - Different Heat Pump Circuits. Energy efficient AC system Star Rating.

Text Books:

1. Refrigeration and Air Conditioning, C P Arora, TMH, 15/e, 2013.
2. S. C Arora & Domkundwar, A Course in Refrigeration and Air conditioning, Dhanpatrai & Co, 2018.

Reference Books:

1. Refrigeration and Air Conditioning / Manohar Prasad / New Age, 2/e, 2013
2. Principles of Refrigeration - Dossat / Pearson Education, 4/e, 2007
3. Refrigeration and Air Conditioning-P.L.Ballaney, 2/e, 2012.
4. Basic Refrigeration and Air-Conditioning - P.N.Ananthanarayanan / TMH, 4/e, 2013.

NOTE: Tables/Codes: Thermal Engineering Data Book containing refrigerant and Psychrometric property Tables and charts are permitted in Exam.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Refrigeration & Air Conditioning	CO1	3	2										2	
	CO2	2	3	2									2	1
	CO3	2	3	2									1	1
	CO4	3	2	1									1	1
	CO5	2	3	1									2	

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	20	22	3	Analyze	L4	PO1 PO2	Apply (L3) Identify (L3)	3 3
2	18	20	2	Apply	L3	PO1 PO2 PO3	Apply (L3) Identify (L3) Apply (L3)	3 3 3
3	20	22	3	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Apply (L3)	3 3 3
4	17	18	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Apply (L3)	3 3 3
5	15	16	2	Analyze	L4	PO1 PO2 PO3	Apply (L3) Identify (L3) Apply (L3)	3 3 3

Justification Statements:

CO1: Analyze the principles of refrigeration and the performance of air refrigeration systems, including aircraft applications.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO1 Action verb is greater than PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**



CO1 Action verb is greater than PO2 verb. Therefore, the correlation is high (3).

CO2: Apply thermodynamic principles and solve problems related to vapor compression refrigeration cycles using P-h and T-S diagrams.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO2: Action verb is at the same level as PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO2: Action verb is at the same level as PO2 verb. Therefore, the correlation is high (3).

PO3 Verb: **Apply (L3)**

CO2: Action verb is at the same level as PO3 verb. Therefore, the correlation is high (3).

CO3: Analyze the operation of Vapour absorption and Steam Jet Refrigeration Technologies.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO3: Action verb is greater than PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO3: Action verb is greater than PO2 verb. Therefore, the correlation is high (3).

PO1 Verb: **Apply (L3)**

CO3 Action verb is greater than PO3 verb. Therefore, the correlation is high (3).

CO4: Evaluate air conditioning processes using psychometric charts.

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO4: Action verb is greater than PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO4: Action verb is greater than PO2 verb. Therefore, the correlation is high (3).

PO1 Verb: **Apply (L3)**

CO4: Action verb is greater than PO3 verb. Therefore, the correlation is high (3).

CO5: Analyze appropriate air conditioning equipment based on comfort requirements and system needs.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO5: Action verb is greater than PO1 verb. Therefore, the correlation is high (3).

PO2 Verb: **Identify (L3)**

CO5: Action verb is greater than PO2 verb. Therefore, the correlation is high (3).

PO1 Verb: **Apply (L3)**

CO5: Action verb is greater than PO3 verb. Therefore, the correlation is high (3).



Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0319	Mechatronics & MEMS	2	1	0	3

Course Outcomes:

- CO: 1 Analyze the key elements, design processes and applications of mechatronic systems in an industrial context.
- CO: 2 Evaluate sensors based on their static and dynamic characteristics to select the appropriate one for a given mechatronic application.
- CO: 3 Evaluate actuator systems, including hydraulic and pneumatic circuits, for specific automation tasks.
- CO: 4 Apply PLC ladder logic programs for industrial automation tasks.
- CO: 5 Analyze MEMS fabrication techniques and the effect of scaling on the performance of micro-electromechanical systems

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	The key elements, design processes and applications of mechatronic systems.	in an industrial context.		L4
CO2	Evaluate	sensors based on their static and dynamic characteristics.	to select the appropriate one for a given mechatronic application.		L5
CO3	Evaluate	actuator systems, including hydraulic and pneumatic circuits.	for specific automation tasks.		L5
CO4	Apply	PLC ladder logic programs.	for industrial automation tasks		L3
CO5	Analyze	MEMS fabrication techniques and the effect of scaling on the performance of micro-electromechanical systems.			L4

UNIT I

Introduction

Definition of Mechatronics, Need for Mechatronics in Industry, Objectives of mechatronics, mechatronics design process, Mechatronics key elements, mechatronics applications – Computer numerical control (CNC) machines, Tool monitoring systems, Flexible manufacturing system (FMS), Industrial Robots, Automatic packaging systems, Automatic inspection systems.

UNIT II

Sensors

Static and dynamic characteristics of sensors, Displacement, Position and Proximity sensors, Force and torquesensors, Pressure sensors, Flow sensors, Temperature sensors, Acceleration sensors, Level sensors, Light sensors, Smart material sensors, Micro and Nano sensors, Selection criteria for sensors.

UNIT III

Actuators

Mechanical, Electrical, Hydraulic and Pneumatic Actuation systems, Characteristics and their limitations, Design of Hydraulic and Pneumatic circuits, Piezoelectric actuators, Shape memory alloys, Selection criteria for actuators.

UNIT IV

Microprocessors, Microcontrollers and Programmable Logic Controllers

Architecture of Microprocessor, Microcontroller and Programmable Logic Controller, PLC Programming using ladder diagrams, logics, latching, sequencing, timers, relays and counters, data handling, Analog input/output, selection of controllers.



UNITV

Micro Electro Mechanical Systems (MEMS)

History, Effect of scaling, Fabrication Techniques: Oxidation, Physical Vapor Deposition, Chemical Vapor Deposition, Lithography, Etching, Wafer bonding, LIGA, DRIE, Applications: Lab on chip.

Textbooks:

1. Bolton, Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering, 3/e, Pearson Education Press, 2005.
2. Devadas Shetty and Richard A Kolk, Mechatronic System Design, 2/e, Cengage Learning, 2010.
3. N. Mahalik, MEMS, McGraw Hill Education, 2017.

Reference Books:

1. Clarence W. de Silva, Mechatronics an Integrated Approach, CRC Press, 2004.
2. James Jallen, Micro Electro Mechanical Systems Design, CRC Press Taylor & Francis group, 2005.
3. Ganesh S Hedge, Mechatronics, Jones & Bartlett Learning, 2010.
4. Mohammed Gad, MEMS; Design and Fabrication, CRC Press, 2010.

Online Learning Resources:

- https://onlinecourses.nptel.ac.in/noc22_me54/preview
- <https://nptel.ac.in/courses/112108092>
- <https://nptel.ac.in/courses/112101304>
- https://onlinecourses.nptel.ac.in/noc20_ee56/preview
- https://www.cet.edu.in/noticefiles/259_Lecturer%20Note%20on%20Mechatronics-ilovepdf-compressed.pdf
- <https://lecturenotes.in/subject/1176/mechatronics-and-mems>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Mechatronics & MEMS	CO1	3	3	2									3	2
	CO2		3	3	2								3	3
	CO3		3	3		3							3	3
	CO4		2	3		3							3	3
	CO5	3	3		2								3	2

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	18	23	3	Analyze	L4	PO1 PO2 PO3	Apply(L3) Analyze(L4) Develop(L3)	3 3 3
2	15	19	2	Evaluate	L5	PO2 PO3 PO4	Apply(L3) Analyze(L4) Develop(L3)	3 3 3
3	15	19	2	Evaluate	L5	PO2 PO3 PO5	Apply(L3) Analyze(L4) Develop(L3)	3 3 3
4	15	19	2	Apply	L3	PO2 PO3 PO5	Apply(L3) Analyze(L4) Develop(L3)	3 2 3
5	16	21	3	Analyze	L4	PO1 PO2 PO4	Apply(L3) Analyze(L4) Develop(L3)	3 3 3

Justification Statements:

CO1: Analyze the key elements, design processes and applications of mechatronic systems in an industrial context.

Action Verb: Analyze (L4)



Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)
MECHANICAL ENGINEERING (ME)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO2: Evaluate sensors based on their static and dynamic characteristics to select the appropriate one for a given mechatronic application.

Action Verb: Evaluate (L5)

PO2Verb: **Apply (L3)**

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Analyze (L4)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO3: Evaluate actuator systems, including hydraulic and pneumatic circuits, for specific automation tasks.

Action Verb: Evaluate (L5)

PO2Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Analyze (L4)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

CO4: Apply PLC ladder logic programs for industrial automation tasks.

Action Verb: Apply (L3)

PO2Verb: **Apply (L3)**

CO4 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Analyze (L4)**

CO4 Action verb is same level (lesser) as PO2 verb. Therefore, the correlation is medium (2)

PO5 Verb: **Develop (L3)**

CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

CO5: Analyze MEMS fabrication techniques and the effect of scaling on the performance of micro-electromechanical systems.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO5 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
(Autonomous)

Course structure for Four Year Regular B.Tech. Degree Program
(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

AK23 Regulations

Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0320	Power Plant Engineering	2	1	0	3

Course Outcomes:

- CO: 1 Understand the concepts of different sources of energies, basics of power generation and environmental aspects.
- CO: 2 Analyze the concepts of Boilers and working of Steam power plant.
- CO: 3 Analyze the working of Diesel power plant and Gas power plant.
- CO: 4 Analyze the working of Hydroelectric power plants in Dams.
- CO: 5 Evaluate renewable energy harvesting methods and safety/waste-management criteria for nuclear reactors.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the concepts of different sources of energies, basics of power generation and environmental aspects			L2
CO2	Analyze	the concepts of Boilers and working of Steam power plant			L4
CO3	Analyze	the working of Diesel power plant and Gas power plant			L4
CO4	Analyze	the working of Hydroelectric power plants in Dams			L4
CO5	Evaluate	Renewable energy harvesting methods and safety/waste-management criteria for nuclear reactors.			L5

Unit I:

Introduction to the Sources of Energy - Resources and Development of Power in India. Conventional and non-conventional energy sources, Power Plant Economics and Environmental Considerations: Capital Cost, Investment of Fixed Charges, Operating Costs, General Arrangement of Power Distribution, Load Curves, Load Duration Curve. Definitions of Connected Load, Maximum Demand, Demand Factor, Average Load, Load Factor, Diversity Factor - Tariff - Related Exercises. Effluents from Power Plants and Impact on Environment - Pollutants and Pollution Standards - Methods of Pollution Control. Inspection And Safety Regulations.

Unit II

Steam PowerPlant : Introduction to Boilers- Modern High Pressure and Supercritical Boilers - Analysis of Power Plant Cycles - Modern Trends in Cycle Improvement - Waste Heat Recovery, Fluidized Bed Boilers., Fuel and Handling Equipments, Types of Coals, Coal Handling, Choice of Handling Equipment, Coal Storage, Ash Handling Systems.

Steam Power Plant : Combustion Process : Properties of Coal - Overfeed and Under Feed Fuel Beds, Travelling Grate Stokers, Spreader Stokers, Retort Stokers, Pulverized Fuel Burning System And Its Components, Combustion Needs and Draught System, Cyclone Furnace, Design and Construction, Dust Collectors, Cooling Towers And Heat Rejection. Analysis of Pollution from Thermal Power Plants - Pollution Controls.CO2 Recorders

Unit III

Diesel Power Plant: Diesel Power Plant, Construction, Plant lay out with auxiliaries, fuel storage.

Gas Turbine Plant: Introduction - Classification - Construction - Layout with Auxiliaries - Principles of Working Closed and Open Cycle Gas Turbines. Advantages And Disadvantages Combined Cycle Power Plants.



Unit IV

Hydro Electric Power Plant: Water Power - Hydrological Cycle / Flow Measurement - Drainage Area Characteristics - Hydrographs - Storage and Pondage - Classification of Dams and Spill Ways. Hydro Projects Plant: Types - Typical Layouts - Plant Auxiliaries - Plant Operation Pumped Storage Plants.

Unit V

Power from Non-Conventional Sources: Utilization of Solar Collectors- Working Principle, Wind Energy - Types of Turbines - HAWT & VAWT-Tidal Energy. MHD power Generation. Nuclear Power Station: Nuclear Fuel - Nuclear Fission, Chain Reaction, Breeding and Fertile Materials - Nuclear Reactor -Reactor Operation.

Types of Reactors: Pressurized Water Reactor, Boiling Water Reactor, Sodium-Graphite Reactor, Fast breeder Reactor, Homogeneous Reactor, Gas Cooled Reactor, Radiation Hazards and Shielding - Radioactive Waste Disposal.

Text Books

1. P.K. Nag, —Power Plant Engineering, 3rd edition, TMH, 2013.
2. Wakil, —Power plant technology, M.M.EI TMH Publications

Reference Books:

1. Rajput, —A Text Book of Power Plant Engineering:, 4th edition, Laxmi Publications, 2012.
2. Ramalingam, —Power plant Engineering, Scietech Publishers, 2013
3. P.C. Sharma, —Power Plant Engineering, S.K. Kataria Publications, 2012.
4. Arora and S.Domakundwar, —A course in Power Plant Engineering, DhanpatRai& Co (p) Ltd, 2014.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Power Plant Engineering	CO1	2	2	2									3	2
	CO2	3	3		3								3	2
	CO3	3	3		3								3	2
	CO4	3	3		3								3	2
	CO5	2	2	2									3	2

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	14	23.33	3	Understand	L2	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop(L3)	2 2 2
2	12	20	2	Analyze	L4	PO1 PO2 PO4	Apply (L3) Identify (L3) Analyze(L4)	3 3 3
3	11	18.33	2	Analyze	L4	PO1 PO2 PO4	Apply (L3) Identify (L3) Analyze(L4)	3 3 3
4	12	20	2	Analyze	L4	PO1 PO2 PO4	Apply (L3) Identify (L3) Analyze(L4)	3 3 3
5	11	18.33	2	Evaluate	L5	PO1 PO2 PO3	Apply (L3) Identify (L3) Develop(L3)	3 3 3



Justification Statements:

CO1:Understand the concepts of different sources of energies, basics of power generation and environmental aspects

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is less than PO1 verb by one level. Therefore, the correlation is medium (2)

PO2 Verb: **Identify (L3)**

CO1 Action verb is less than PO2 verb by one level. Therefore, the correlation is medium (2)

PO3 Verb: **Develop(L3)**

CO1 Action verb is less than PO3 verb by one level. Therefore, the correlation is medium (2)

CO2:Analyze the concepts of Boilers and working of Steam power plant.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO2 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify(L3)**

CO2 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO4Verb: **Analyze(L4)**

CO2 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

CO3:Analyze the working of Diesel power plant and Gas power plant.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO3 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify(L3)**

CO3 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO4Verb: **Analyze(L4)**

CO3 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

CO4:Analyze the working of Hydroelectric power plants in Dams

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO4 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify(L3)**

CO4 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO4Verb: **Analyze(L4)**

CO4 Action verb is same as PO4 verb. Therefore, the correlation is high (3)

CO5: Evaluate renewable energy harvesting methods and safety/waste-management criteria for nuclear reactors.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO5 Action verb is greater than PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify (L3)**

CO5 Action verb is greater than PO2 verb. Therefore, the correlation is high (3)

PO3Verb: **Develop (L4)**

CO5 Action verb is same as PO4 verb. Therefore, the correlation is high (3)



Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0321	Non-Conventional Energy Sources	2	1	0	3

Course Outcomes:

- CO: 1 Analyze solar radiation data and the environmental impact of solar power.
CO: 2 Evaluate the thermal performance of solar energy collectors for specific applications.
CO: 3 Analyze Solar Thermal Storage Methods and Aerodynamic Wind Turbines.
CO: 4 Analyze Bio-Gas Digesters and Geothermal Harnessing Subsystems.
CO: 5 Analyze ocean power plants and Direct Energy Conversion (DEC) systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	Solar radiation data and the environmental impact of solar power.			L4
CO2	Evaluate	the thermal performance of solar energy collectors.	for specific applications.		L5
CO3	Analyze	Solar Thermal Storage Methods and Aerodynamic Wind Turbines.			L4
CO4	Analyze	Bio-Gas Digesters and Geothermal Harnessing Subsystems			L4
CO5	Analyze	ocean power plants and Direct Energy Conversion (DEC) systems.			L4

UNIT- I

PRINCIPLES OF SOLAR RADIATION: Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extra-terrestrial and terrestrial solar radiation, solar radiation on tilted surface, instruments for measuring solar radiation and sunshine, solar radiation data.

UNIT-II

SOLAR ENERGY COLLECTION: Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

UNIT-III

SOLAR ENERGY STORAGE AND APPLICATIONS: Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

WIND ENERGY: Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betzcriteria

UNIT-IV

BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.

GEOTHERMAL ENERGY: Resources, types of wells, methods of harnessing the energy, potential in India.

UNIT-V

OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics.



DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, and principles of DEC. Thermo-electric generators, Seebeck, Peltier and Joule Thomson effects, Figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD Engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principles, faraday 'slaw's, thermodynamic aspects, selection of fuels and operating conditions

TEXTBOOKS:

1. Non-Conventional Energy Sources/ G.D.Rai Khanna Publisher
2. Energy Resources Utilization and Technologies, Anjaneyulu Yerramilli, Francis Tului, BSPublications, 2012

REFERENCES:

1. Renewable Energy Sources /Twidell & Weir 3rd edition Routledge publisher(2015)
2. Non-Conventional Energy Resources, B.H.Khan, McGrawHill,2015
3. Solar Power Engineering /B.S.Magal Frank Kreith & J.F.Kreith.
4. Principles of Solar Energy/Frank Krieth &J ohn FKreider.
5. Non-Conventional Energy/Ashok V Desai/Wiley Eastern

OnlineLearningResources:

- https://youtube.com/playlist?list=PL3QMEfkoIRFbGhXveCE7RFDBgY0_gRxxh&si=ZYwAnUNtmIwsIq
- <https://youtube.com/playlist?list=PLfxYQ3zfSrafm79OhjA7hvdCgm29EKrcq&si=wBQZsw0JtePVc2f->
- <https://youtube.com/playlist?list=PLcWcvGXrBFerV7f9oyuuX9RabYUuanGrK&si=TVHISydk9cPw5MsV.>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Non-Conventional Energy Sources	CO1	3		2	2		2						3	2
	CO2	3		2	2		2						3	3
	CO3	3		2	2		2						3	3
	CO4	3		2	2		2						3	2
	CO5	3		2	2		2						3	2

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	12	20	2	Analyze	L4	PO1 PO3 PO4 PO6	Apply(L3), Develop(L3), Analyze(L4) Thumb rule	3 3 3 3
2	12	20	2	Evaluate	L5	PO1 PO3 PO4 PO6	Apply(L3), Develop(L3), Analyze(L4) Thumb rule	3 3 3 3
3	12	20	2	Analyze	L4	PO1 PO3 PO4 PO6	Apply(L3), Develop(L3), Analyze(L4) Thumb rule	3 3 3 3
4	12	20	2	Analyze	L4	PO1 PO3 PO4 PO6	Apply(L3), Develop(L3), Analyze(L4) Thumb rule	3 3 3 3
5	12	20	2	Analyze	L4	PO1 PO3 PO4 PO6	Apply(L3), Develop(L3), Analyze(L4) Thumb rule	3 3 3 3



Justification Statements:

CO1: Analyze solar radiation data and the environmental impact of solar power.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Identify (L3)**

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: **Develop (L3)**

CO1 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO1 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO2: Evaluate the thermal performance of solar energy collectors for specific applications.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO2 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Identify (L3)**

CO2 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: **Develop (L3)**

CO2 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO2 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO3: Analyze Solar Thermal Storage Methods and Aerodynamic Wind Turbines.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO3 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Identify (L3)**

CO3 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: **Develop (L3)**

CO3 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO3 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO4: Analyze Bio-Gas Digesters and Geothermal Harnessing Subsystems.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Identify (L3)**

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: **Develop (L3)**

CO4 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO4 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO5: Analyze ocean power plants and Direct Energy Conversion (DEC) systems.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO3 Verb: **Identify (L3)**

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: **Develop (L3)**

CO5 Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO5 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)



Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0322	Automation & Robotics	2	1	0	3

Course Outcomes:

- CO: 1 Analyze automation levels, strategies and high-speed handling hardware components in manufacturing industries.
- CO: 2 Evaluate automated transfer flow lines and optimize operational efficiencies using assembly line balancing methods.
- CO: 3 Analyze robotic structural configurations, end-effectors, actuators and sensing systems.
- CO: 4 Apply transformation techniques and D-H notation to solve problems in robot kinematics and evaluate actuator and sensor selection.
- CO: 5 Analyze robotic control programs and evaluate strategic manipulator deployments for industrial manufacturing cells.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	automation levels, strategies and high-speed handling hardware components		in manufacturing industries.	L4
CO2	Evaluate	automated transfer flow lines and optimize operational efficiencies	using assembly line balancing methods.		L5
CO3	Analyze	robotic structural configurations, end-effectors, actuators and sensing systems.			L4
CO4	Apply	transformation techniques and D-H notation to solve problems in robot kinematics and evaluate actuator and sensor selection.			L3
CO5	Analyze	robotic control programs and evaluate strategic manipulator deployments for industrial manufacturing cells.			L4

Unit I: Introduction to Automation: Introduction to Automation, Need, Types, Basic elements of an automated system, Manufacturing Industries, Types of production, Functions in manufacturing, Organization and information processing in manufacturing, Automation strategies and levels of automation, Hardware components for automation and process control, mechanical feeders, hoppers, orienters, high speed automatic insertion devices.

Unit II

Automated flow lines: Automated flow lines, Part transfer methods and mechanisms, types of Flow lines, flow line with/without buffer storage, Quantitative analysis of flow lines. Assembly line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

Unit III

Introduction to Industrial Robotics: Introduction to Industrial Robotics, Classification of Robot Configurations, functional line diagram, degrees of freedom. Components common types of arms, joints grippers, factors to be considered in the design of grippers. Robot actuators and Feedback components: Actuators, Pneumatic, Hydraulic actuators, Electric & Stepper motors, comparison. Position sensors - potentiometers, resolvers, encoders - velocity sensors, Tactile sensors, Proximity sensors.

Unit IV

Manipulator Kinematics: Manipulator Kinematics, Homogenous transformations as applicable to rotation and transition - D-H notation, Forward inverse kinematics. Manipulator Dynamics: Differential transformations, Jacobians, Lagrange - Euler and Newton - Euler formations. Trajectory Planning: Trajectory Planning and avoidance of obstacles path planning, skew motion, joint integrated motion - straight line motion.

Unit V

Robot Programming: Robot Programming, Methods of programming - requirements and features of programming languages, software packages. Problems with programming languages. Robot Application in Manufacturing:



ANNAMACHARYA INSTITUTE OF TECHNOLOGY AND SCIENCES, TIRUPATI
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Course structure for Four Year Regular B.Tech. Degree Program

(Effective for the batches admitted from 2023-24)

MECHANICAL ENGINEERING (ME)

Material Transfer - Material handling, loading and unloading - Process - spot and continuous arc welding & spray painting - Assembly and Inspection.

Text Books:

1. Automation, Production systems and CIM, M.P. Groover /4thEdition, Pearson education (2016)
2. Industrial Robotics - M.P. Groover, TMH (1996)

Reference Books:

1. Robotics, Fu K S, McGraw Hill, 4th edition, 2010.
2. An Introduction to Robot Technology, P. Coiffet and M. Chaironze, Kogam Page Ltd. 1983 London.
3. Robotic Engineering, Richard D. Klafter, Prentice Hall
4. Robotics, Fundamental Concepts and analysis – AshitaveGhosal, Oxford Press, 1/e, 2006
5. Robotics and Control, Mittal R K & Nagrath I J, TMH.

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Automation & Robotics	CO1	3	3				3						2	2
	CO2	3	3										2	2
	CO3	3	3			3	2						2	2
	CO4	3	3	3		2							2	2
	CO5	3	3			3	1						2	2

Correlation Matrix

CO	Percentage of contact hours over the total planned contact hours			CO		Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	22	27	3	Analyze	L4	PO1 PO2 PO6	Apply (L3) Identify (L3) Thumb rule	3 3 3
2	20	24	3	Evaluate	L5	PO1 PO2	Apply (L3) Identify (L3)	3 3
3	14	17	2	Analyze	L4	PO1 PO2 PO5 PO6	Apply (L3) Identify (L3) Apply (L3) Thumb rule	3 3 3 3
4	16	20	2	Apply	L3	PO1 PO2 PO3 PO5	Apply (L3) Identify (L3) Develop (L3) Apply (L3)	3 3 3 3
5	11	14	2	Analyze	L4	PO1 PO2 PO5 PO6	Apply (L3) Identify (L3) Develop (L3) Thumb rule	3 3 3 3

Justification Statements:

CO1: Analyze automation levels, strategies and high-speed handling hardware components in manufacturing industries.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO1 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO1 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO1 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO2: Evaluate automated transfer flow lines and optimize operational efficiencies using



assembly line balancing methods.

Action Verb: Evaluate (L5)

PO1Verb: **Apply (L3)**

CO2:Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify (L3)**

CO2:Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

CO3: Analyze robotic structural configurations, end-effectors, actuators and sensing systems.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO3:Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify (L3)**

CO3:Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO5Verb: **Apply (L3)**

CO3: Action verb is same level (greater) as PO5 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO3 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO4:Apply kinematic and dynamic modeling using D-H notation and select appropriate hardware and control strategies for real-world industrial scenario.

ActionVerb:Evaluate(L5)

PO1Verb: **Apply (L3)**

CO4:Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify (L3)**

CO4:Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO3Verb: **Develop (L3)**

CO4: Action verb is same level (greater) as PO3 verb. Therefore, the correlation is high (3)

PO5Verb: **Apply (L3)**

CO4: Action verb is same level (greater) as PO5 verb. Therefore, the correlation is high (3)

CO5: Analyze robotic control programs and evaluate strategic manipulator deployments for industrial manufacturing cells.

Action Verb: Analyze (L4)

PO1Verb: **Apply (L3)**

CO5:Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2Verb:**Identify (L3)**

CO5:Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO5Verb: **Develop (L3)**

CO5: Action verb is same level (lesser) as PO5 verb. Therefore, the correlation is high (2)

PO6 Verb: Thumb Rule

As per thumb rule CO3 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)



Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0323	Non-Destructive Testing	2	1	0	3

Course Outcomes:

- CO: 1 Understand the principles and safety protocols of industrial radiography.
CO: 2 Apply ultrasonic testing concepts to analyze material characteristics and defects.
CO: 3 Apply liquid penetrant, eddy current and magnetic particle testing techniques to detect and analyze material defects.
CO: 4 Analyze structural and thermal anomalies using infrared thermography techniques.
CO: 5 Analyze NDE techniques for diverse industrial applications including aerospace, nuclear and automotive sectors.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the principles and safety protocols of industrial radiography.			L2
CO2	Apply	Ultrasonic testing concepts to analyze material characteristics and defects.			L3
CO3	Apply	Liquid penetrant, eddy current and magnetic particle testing techniques.	to detect and analyze material defects.		L3
CO4	Analyze	structural and thermal anomalies using Infrared Thermography techniques			L4
CO5	Analyze	NDE techniques.	for diverse industrial applications including aerospace, nuclear and automotive sectors.		L4

UNIT -I

Introduction to non-destructive testing: Radiographic test, Sources of X and Gamma Rays and their interaction with Matter, Radiographic equipment, Radiographic Techniques, Safety Aspects of Industrial Radiography.

UNIT - II

Ultrasonic test: Principle of Wave Propagation, Reflection, Refraction, Diffraction, Mode Conversion and Attenuation, Sound Field, Piezo-electric Effect, Ultrasonic Transducers and their Characteristics, Ultrasonic Equipment and Variables Affecting Ultrasonic Test, Ultrasonic Testing, Interpretations and Guidelines for Acceptance, Rejection-Effectiveness and Limitations of Ultrasonic Testing.

UNIT – III

Liquid penetrant, Eddy Current & Magnetic Particle Test

Liquid Penetrant Test: Liquid Penetrant Test, Basic Concepts, Liquid Penetrant System, Test Procedure, Effectiveness and Limitations of Liquid Penetrant Testing.

Eddy Current Test: Principle of Eddy Current, Eddy Current Test System, Applications of Eddy Current-Testing Effectiveness of Eddy Current Testing.

Magnetic Particle Test: Magnetic Materials, Magnetization of Materials, Demagnetization of Materials, Principle of Magnetic Particle Test, Magnetic Particle Test Equipment, Magnetic Particle Test Procedure, Standardization and Calibration, Interpretation and Evaluation, Effective Applications and Limitations of the Magnetic Particle Test

Unit IV

Infrared and Thermal Testing: Introduction and fundamentals to infrared and thermal testing–Heattransfer –Active and passive techniques –Lock in and pulse thermography– Contact and non-contact thermal inspection methods–Heat sensitive paints–Heat sensitive papers–thermally quenched phosphors liquid crystals–techniques for applying liquid crystals–other temperature sensitive coatings



–Inspection methods –Infrared radiation and infrared detectors–thermo mechanical behavior of materials–IR imaging in aerospace applications, electronic components, Honeycomb and sandwich structures–Casestudies.

UNIT-V

Industrial Applications of NDE: Span of NDE Activities Railways, Nuclear, Non-nuclear and Chemical Industries, Aircraft and Aerospace Industries, Automotive Industries, Offshore Gas and Petroleum Projects, Coal Mining Industry, NDE of pressure vessels, castings, welded constructions.

Text Books:

1. J Prasad, GCK Nair, Non destructive test and evaluation of Materials, Tata mcgraw-Hill Education Publishers, 2008.
2. Josef Krautkrämer, Herbert Krautkrämer, Ultrasonic testing of materials, 3/e, Springer-Verlag, 1983.
3. X.P.V. Maldague, Non- destructive evaluation of materials by infrared thermography, 1/e, Springer-Verlag, 1993.

Reference Books:

1. Gary L. Workman, Patrick O. Moore, Doron Kishoni, Non-destructive, Handbook, Ultrasonic Testing, 3/e, Amer Society for Nondestructive, 2007.
2. ASTM Standards, Vol 3.01, Metals and alloys.

Online Learning Resources:

- <http://www.twivirtualacademy.com/online-courses/ndt/>
- <https://www.classcentral.com/course/swayam-theory-and-practice-of-non-destructive-testing-9872>
- https://onlinecourses.nptel.ac.in/noc20_mm07/preview
- <https://www.youtube.com/watch?v=dyMR58TZMbo> <https://www.youtube.com/watch?v=Wam-Ewcn3aQ>
- https://www.iare.ac.in/sites/default/files/lecture_notes/IARE_NDT_Lecture_Notes.pdf
- <https://lecturenotes.in/subject/390/non-destructive-testing>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Non-Destructive Testing	CO1	3	3		2		2						2	2
	CO2	3	3		2		2						2	2
	CO3	3	3		2		2						2	2
	CO4	3	3		2		2						2	2
	CO5	3	3		2		-2						2	2

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	14	23.33	3	Understand	L2	PO1	Apply(L3)	2
						PO2	Identify (L3)	2
						PO4	Analyze(L4)	1
						PO6	Thumb rule	2
2	12	20	2	Apply	L3	PO1	Apply(L3)	3
						PO2	Identify (L3)	3
						PO4	Analyze(L4)	2
						PO6	Thumb rule	3
3	11	18.33	2	Apply	L3	PO1	Apply(L3)	3
						PO2	Identify (L3)	3
						PO4	Analyze(L4)	2
						PO6	Thumb rule	3
4	12	20	2	Analyze	L4	PO1	Apply(L3)	3
						PO2	Identify (L3)	3
						PO4	Analyze(L4)	3
						PO6	Thumb rule	3



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5	11	18.33	2	Analyze	L4	PO1 PO2 PO4 PO6	Apply(L3) Identify (L3) Analyze(L4) Thumb rule	3 3 3 3
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Justification Statements:

CO1: Understand the principles and safety protocols of industrial radiography.

Action Verb: Understand (L2)

PO1Verb: Apply (L3)

CO1 Action verb is same level (lesser) as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: Identify (L3)

CO1 Action verb is same level (lesser) as PO2 verb. Therefore, the correlation is medium (2)

PO4 Verb: Analyze (L4)

CO1 Action verb is same level (lesser) as PO3 verb. Therefore, the correlation is low (1)

PO6 Verb: Thumb Rule

As per thumb rule CO1 co-relates slightly with PO6 verb. Therefore, the correlation is medium (2)

CO2: Apply ultrasonic testing concepts to analyze material characteristics and defects.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO2 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: Analyze (L4)

CO2 Action verb is same level (lesser) as PO3 verb. Therefore, the correlation is medium (2)

PO6 Verb: Thumb Rule

As per thumb rule CO2 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO3: Apply liquid penetrant, eddy current, and magnetic particle testing techniques to detect and analyze material defects.

Action Verb: Apply (L3)

PO1Verb: Apply (L3)

CO3 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO3 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: Analyze (L4)

CO3 Action verb is same level (lesser) as PO3 verb. Therefore, the correlation is medium (2)

PO6 Verb: Thumb Rule

As per thumb rule CO3 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO4: Analyze structural and thermal anomalies using Infrared Thermography techniques.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO4 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO4 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: Analyze (L4)

CO4 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO4 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO5: Analyze NDE techniques for diverse industrial applications, including aerospace, nuclear and automotive sectors.

Action Verb: Analyze (L4)

PO1Verb: Apply (L3)

CO5 Action verb is same level (greater) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: Identify (L3)

CO5 Action verb is same level (greater) as PO2 verb. Therefore, the correlation is high (3)

PO4 Verb: Analyze (L4)

CO5 Action verb is same level as PO3 verb. Therefore, the correlation is high (3)

PO6 Verb: Thumb Rule

As per thumb rule CO5 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)



Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0324	Total Quality Management	2	1	0	3

Course Outcomes:

- CO: 1 Understand the fundamental concepts, philosophies and costs of Total Quality Management.
- CO: 2 Evaluate the strategic philosophies of quality gurus and analyze barriers to successful TQM leadership.
- CO: 3 Apply process improvement frameworks and build collaborative stakeholder relationships.
- CO: 4 Analyze operational and design issues using statistical and management tools of quality.
- CO: 5 Evaluate compliance requirements for global quality management systems and manage auditing procedures.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	The fundamental concepts, philosophies, and costs of Total Quality Management.			L2
CO2	Evaluate	the strategic philosophies of quality gurus and analyze barriers to successful TQM leadership.			L5
CO3	Apply	process improvement frameworks and build collaborative stakeholder relationships.			L3
CO4	Analyze	operational and design issues	using statistical and management tools of quality.		L4
CO5	Evaluate	compliance requirements for global quality management systems and manage auditing procedures.			L5

Unit I:

Introduction: Definition of Quality, Dimensions of Quality, Definition of Total quality management, Quality Planning, Quality costs – Analysis, Techniques for Quality costs, Basic concepts of Total Quality Management.

Unit II

Historical Review: Quality council, Quality statements, Strategic Planning, Deming Philosophy, Barriers of TQM Implementation, Benefits of TQM, Characteristics of successful quality leader, Contributions of Gurus of TQM, Case studies.

Unit III

TQM Principles: Customer Satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment teams, Continuous Process Improvement – Juran Trilogy, PDCA Cycle, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure Case studies.

Unit IV

TQM Tools: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA, The seven tools of quality, Process capability, Concept of Six Sigma, New Seven management tools, Case studies.

Unit V

Quality Systems: Need for ISO9000 and Other Quality Systems, ISO9000: 2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits, Case Studies.



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Text Books:

1. Dale H Besterfield, Total Quality Management, Fourth Edition, Pearson Education, 2015.
2. Subburaj Ramaswamy, Total Quality Management, Tata Mcgraw Hill Publishing Company Ltd., 2005.
3. Joel E.Ross, Total Quality Management, Third Edition, CRC Press, 2017

Reference Books:

1. Narayana V and Sreenivasan N.S, Quality Management – Concepts and Tasks, New Age International, 1996.
2. Robert L.Flood, Beyond TQM, First Edition, John Wiley & Sons Ltd, 1993.
3. Richard S.Leavenworth & Eugene Lodewick Grant, Statistical Quality Control, Seventh Edition, Tata Mcgraw Hill, 2015
4. Samuel Ho, TQM – An Integrated Approach, Kogan Page Ltd, USA, 1995.

Online Learning Resources:

- <https://www.youtube.com/watch?v=VD6tXadibk0>
- <https://www.investopedia.com/terms/t/total-quality-management-tqm.asp>
- <https://blog.capterra.com/what-is-total-quality-management/>
- <https://nptel.ac.in/courses/110/104/110104080/>
- https://onlinecourses.nptel.ac.in/noc21_mg03/preview
- <https://nptel.ac.in/courses/110/104/110104085/>
- <https://nptel.ac.in/noc/courses/noc18/SEM2/noc18-mg39/>

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)													
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	
Total Quality Management	CO1	2	2				2						2	2	
	CO2	2	2				2						2	2	
	CO3	2	2				2						2	2	
	CO4	2	2				2						2	2	
	CO5	2	2				2						2	2	

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	10	20	2	Understand	L2	PO1 PO2 PO6	Apply (L3) Identify (L3) Thumb rule	2 2 2
2	10	20	2	Evaluate	L5	PO1 PO2 PO6	Apply (L3) Identify (L3) Thumb rule	3 3 3
3	10	20	2	Apply	L3	PO1 PO2 PO6	Apply (L3) Identify (L3) Thumb rule	3 3 3
4	10	20	2	Analyze	L4	PO1 PO2 PO6	Apply (L3) Identify (L3) Thumb rule	3 3 3
5	10	20	2	Evaluate	L5	PO1 PO2 PO6	Apply (L3) Identify (L3) Thumb rule	3 3 3

Justification Statements:

CO1: Understand the fundamental concepts, philosophies and costs of Total Quality Management.

Action Verb: Understand (L2)

PO1 Verb: **Apply (L3)**

CO1 Action verb is low level as PO1 verb. Therefore, the correlation is medium (2)

PO2 Verb: **Identify (L3)**

CO1 Action verb is low level as PO2 verb. Therefore, the correlation is medium (2)



As per thumb rule CO1 co-relates slightly with PO6 verb. Therefore, the correlation is medium (2)

CO2: Evaluate the strategic philosophies of quality gurus and analyze barriers to successful TQM leadership.

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO2 Action verb is same level (higher) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO2 Action verb is same level (higher) as PO2 verb. Therefore, the correlation is high (3)

As per thumb rule CO2 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO3: Apply process improvement frameworks and build collaborative stakeholder relationships.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO3 Action verb is same level (higher) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO3 Action verb is same level (higher) as PO2 verb. Therefore, the correlation is high (3)

As per thumb rule CO3 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO4: Analyze operational and design issues using statistical and management tools of quality.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO4 Action verb is same level (higher) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO4 Action verb is same level (higher) as PO2 verb. Therefore, the correlation is high (3)

As per thumb rule CO4 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)

CO5: Evaluate compliance requirements for global quality management systems and manage auditing procedures.

Action Verb: Evaluate (L5)

PO1 Verb: **Apply (L3)**

CO5 Action verb is same level (higher) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Identify (L3)**

CO5 Action verb is same level (higher) as PO2 verb. Therefore, the correlation is high (3)

As per thumb rule CO5 co-relates slightly with PO6 verb. Therefore, the correlation is high (3)



Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23APE0325	Smart Manufacturing	2	1	0	3

Course Outcomes:

- CO: 1 Analyze the key technologies and impact of Industry 4.0 and Cyber-Physical Systems on manufacturing.
- CO: 2 Apply data analytics and artificial intelligence techniques for predictive maintenance and process optimization.
- CO: 3 Analyze the deployment of cloud/edge computing architecture and blockchain technology to optimize real-time supply chains and inventory management.
- CO: 4 Evaluate manufacturing processes using Digital Twin simulations and immersive technologies (AR/VR).
- CO: 5 Analyze eco-efficient manufacturing practices and assess emerging technological pathways toward Industry 5.0.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Analyze	The key technologies and impact of Industry 4.0 and Cyber-Physical Systems.	on manufacturing.		L4
CO2	Apply	Data analytics and artificial intelligence techniques.	for predictive maintenance and process optimization.		L3
CO3	Analyze	the deployment of cloud/edge computing architecture and blockchain technology to optimize real-time supply chains and inventory management.			L4
CO4	Evaluate	Manufacturing processes.	using Digital Twin simulations and immersive technologies (AR/VR).		L5
CO5	Analyze	eco-efficient manufacturing practices and assess emerging technological pathways toward Industry 5.0.			L4

Unit – I

Introduction to Smart Manufacturing

Definition, Evolution, and Importance of Smart Manufacturing, Industry4.0 and Its Impact on Manufacturing, Traditional vs. Smart Manufacturing, Key Technologies in Smart Manufacturing

Cyber-Physical Systems & Industrial IoT (IIoT)

Basics of Cyber-Physical Systems (CPS), Internet of Things (IoT) in Manufacturing, Smart Sensors and Actuators Communication Protocols (MQTT, OPC-UA, Modbus),

Unit – II

Data Analytics and Artificial Intelligence in Manufacturing

Role of Big Data in Manufacturing, Machine Learning & Deep Learning for Smart Manufacturing, Predictive Maintenance and Anomaly Detection, Digital Twin Technology

Automation & Robotics in Smart Manufacturing

Industrial Automation: PLCs, SCADA, and DCS, Autonomous Robots and Cobots (Collaborative Robots), Additive Manufacturing (3DPrinting), Case Studies of Smart Factories.

Unit – III

Cloud Computing and Edge Computing in Manufacturing



Introduction to Cloud Computing for Manufacturing, Edge and Fog Computing in Real-time Manufacturing Systems, Cloud-based Manufacturing Execution Systems (MES).

Smart Sensors, RFID, and Block chain in Manufacturing

Role of Smart Sensors and RFID in Inventory Management, Blockchain for Secure Supply Chains Smart Contracts and Decentralized Manufacturing Systems

Unit- IV

Digital Twin & Simulation in Manufacturing

Digital Twin Technology and Virtual Prototyping, Simulation Software for Smart Manufacturing, Augmented Reality(AR) and Virtual Reality(VR) in Industry4.0

Cybersecurity in Smart Manufacturing

Threats and Risks in Smart Manufacturing, Cybersecurity Frameworks for Industrial Systems, Best Practices for Securing IoT and IIoT Devices

Unit – V

Sustainable and Green Manufacturing

Energy Efficiency in Smart Manufacturing, Sustainable Supply Chain Management, Role of AI in Green Manufacturing

Case Studies and Future Trends

Case Studies of Leading Smart Manufacturing Companies, Emerging Technologies in Smart Manufacturing, Future of Industry5.0 and Beyond

Text Books:

1. Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013
2. Smart manufacturing by Kamalakkar Mutalik The Righteorder(2023)

Reference Books:

1. Introduction To Smart Manufacturing And Automation Dr. Rajkumar. ENamya Press (29March2024); 213, VardanHosue7/28 Ansari Road Daryganj Delhi 110002.
2. SmartManufacturingbyMichael Deng (Author),Colin KohKindleEdition(2023).

Online Learning Resources:

- [https://www.youtube.com/watch?v=sdgI072DJNM&pp=ygUUU01BUIQgTUFOVUZBQ1RVUklORyA%3D\(2023\)](https://www.youtube.com/watch?v=sdgI072DJNM&pp=ygUUU01BUIQgTUFOVUZBQ1RVUklORyA%3D(2023))

Course Title	COs	Programme Outcomes (POs) & Programme Specific Outcomes (PSOs)												
		PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
Smart Manufacturing	CO1	3	2	2									3	2
	CO2	3	3			3							3	3
	CO3			3		3							3	3
	CO4		3	3	3								3	3
	CO5			3			3	3					3	3

Correlation Matrix

CO	CO					Program Outcomes (PO)	PO(s): Action Verb and BTL (for PO1 to PO5)	Level of Correlation
	Lesson Plan (Hrs)	%	Correlation	Verb	BTL			
1	12	20	2	Analyze	L4	PO1, PO2, PO3	Apply(L3), Analyze(L4), Design(L6)	3 3 2
2	12	20	2	Apply	L3	PO1, PO2, PO5	Apply(L3), Analyze(L4), Usage(L3)	3 2 3



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3	12	20	2	Analyze	L4	PO3, PO5	Design(L6), Usage(L3)	2 3
4	12	20	2	Evaluate	L5	PO2, PO3, PO4	Analyze(L4), Design(L6), Analyze(L4)	3 2 3
5	12	20	2	Analyze	L4	PO3, PO6, PO7	Design(L6), Contextual(L3), Sustainability(L3)	2 3 3

Justification Statements:

CO1: Analyze the key technologies and impact of Industry 4.0 and Cyber-Physical Systems on manufacturing.

Action Verb: Analyze (L4)

PO1 Verb: **Apply (L3)**

CO1 Action verb is same level (higher) as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO1 Action verb is same level as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Design (L6)**

CO1 Action verb is low level as PO3 verb. Therefore, the correlation is high (2)

CO2: Apply data analytics and artificial intelligence techniques for predictive maintenance and process optimization.

Action Verb: Apply (L3)

PO1 Verb: **Apply (L3)**

CO2 Action verb is same level as PO1 verb. Therefore, the correlation is high (3)

PO2 Verb: **Analyze (L4)**

CO2 Action verb is low level as PO2 verb. Therefore, the correlation is high (2)

PO5 Verb: **Usage (L3)**

CO2 Action verb is same level as PO5 verb. Therefore, the correlation is high (3)

CO3: Analyze the deployment of cloud/edge computing architecture and blockchain technology to optimize real-time supply chains and inventory management.

Action Verb: Analyze (L4)

PO3 Verb: **Design (L6)**

CO3 Action verb is low level as PO3 verb. Therefore, the correlation is high (2)

PO5 Verb: **Usage (L3)**

CO3 Action verb is same level (higher) as PO5 verb. Therefore, the correlation is high (3)

CO4: Evaluate manufacturing processes using Digital Twin simulations and immersive technologies (AR/VR).

Action Verb: Evaluate (L5)

PO2 Verb: **Analyze (L4)**

CO4 Action verb is same level (higher) as PO2 verb. Therefore, the correlation is high (3)

PO3 Verb: **Design (L6)**

CO5 Action verb is low level as PO3 verb. Therefore, the correlation is high (2)

PO4 Verb: **Analyze (L4)**

CO4 Action verb is same level as PO4 verb. Therefore, the correlation is high (3)

CO5: Analyze eco-efficient manufacturing practices and assess emerging technological pathways toward Industry 5.0.

Action Verb: Analyze (L4)

PO3 Verb: **Design (L6)**

CO5 Action verb is low level as PO3 verb. Therefore, the correlation is high (2)

PO6 Verb: **Contextual (L3)**

CO5 Action verb is same level (higher) as PO6 verb. Therefore, the correlation is high (3)

PO7 Verb: **Sustainability (L3)**

CO5 Action verb is same level (higher) as PO6 verb. Therefore, the correlation is high (3)



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MECHANICAL ENGINEERING (ME)

Year: IV

Semester: I

Branch of Study: ME

Subject Code	Subject Name	L	T/CLC	P	Credits
23ASC0406	Introduction to Drone Technology	0	1	2	2

Course Outcomes: After studying the course, student will be able to

CO1 Understand the fundamentals, classifications, and applications of drone technology.

CO2 Apply drone design, fabrication, assembly, programming, and stabilization techniques using appropriate hardware and software tools.

CO3 Apply appropriate flight modes, sensors, and control mechanisms for safe drone operation.

CO4 Analyze drone technologies for commercial applications in logistics, agriculture, insurance, infrastructure inspection, and aerial imaging.

CO5 Evaluate future drone technologies, safety regulations, licensing requirements, and autonomous systems.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the fundamentals, classifications, and applications of drone technology.			L2
CO2	Apply	drone design, fabrication, assembly, programming, and stabilization techniques	using appropriate hardware and software tools.		L3
CO3	Apply	appropriate flight modes, sensors, and control mechanisms		for safe drone operation.	L3
CO4	Analyze	drone technologies		for commercial applications in logistics, agriculture, insurance, infrastructure inspection, and aerial imaging.	L4
CO5	Evaluate	future drone technologies, safety regulations, licensing requirements, and autonomous systems.			L5

UNIT I

INTRODUCTION TO DRONE TECHNOLOGY

Drone Concept - Vocabulary Terminology- History of drone - Types of current generation of drones based on their method of propulsion- Drone technology impact on the businesses- Drone business through entrepreneurship- Opportunities/applications for entrepreneurship and employability

UNIT II

DRONE DESIGN, FABRICATION AND PROGRAMMING

Classifications of the UAV -Overview of the main drone parts- Technical characteristics of the parts - Function of the component parts -Assembling a drone- The energy sources- Level of autonomy-Drones configurations -The methods of programming drone- Download program -Install program on computer- Running Programs- Multi rotor stabilization- Flight modes -Wi-Fi connection

UNIT III

DRONE FLYING AND OPERATION

Concept of operation for drone -Flight modes- Operate a small drone in a controlled environment-Drone controls Flight operations –management tool –Sensors-Onboard storage capacity -Removable storage devices- Linked mobile devices and applications



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UNIT IV

DRONE COMMERCIAL APPLICATIONS

Choosing a drone based on the application -Drones in the insurance sector- Drones in delivering mail, parcels and other cargo- Drones in agriculture- Drones in inspection of transmission lines and power distribution -Drones in filming and panoramic picturing

UNIT V

FUTURE DRONES AND SAFETY

The safety risks- Guidelines to fly safely -Specific aviation regulation and standardization- Drone license- Miniaturization of drones- Increasing autonomy of drones -The use of drones in swarms

TEXT BOOKS

1. Daniel Tal and John Altschuld, —Drone Technology in Architecture, Engineering and Construction: A Strategic Guide to Unmanned Aerial Vehicle Operation and Implementation, 2021 John Wiley & Sons, Inc.
2. Terry Kilby and Belinda Kilby, —Make:Getting Started with Drones —,Maker Media, Inc,

REFERENCES

1. John Baichtal, —Building Your Own Drones: A Beginners' Guide to Drones, UAVs, and ROVs, Que Publishing, 2016
2. Zavrnsnik, —Drones and Unmanned Aerial Systems: Legal and Social Implications for Security and Surveillancel, Springer, 2018.

LEARNING RESOURCES

<https://nptel.ac.in/courses/101108661>

<https://www.youtube.com/watch?v=iJnuTtUFiWM>

Mapping of Course Outcomes with Program Outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	2	3	2	1	2								2
CO2	3	3	3	2	3								2
CO3	3	3	3	2	3								2
CO4	3	3	3	3	3	1	1						2
CO5	3	3	3	3	3	1	1						2

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan (Hrs)	%	Correlation	Co's Action verb	BT L			
1	21	28%	2	Understand	L2	PO1 PO2 PO3 PO4 PO5	PO1: Apply (L3) PO2: Review (L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply (L3)	2 3 2 1 2
2	12	16%	2	Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply (L3) PO2: Review (L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply (L3)	3 3 3 2 3
3	19	25%	2	Apply	L3	PO1 PO2 PO3 PO4 PO5	PO1: Apply (L3) PO2: Review (L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply (L3)	3 3 3 2 3



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4	12	16%	3	Analyze	L4	PO1 PO2 PO3 PO4 PO5 PO6 PO7	PO1: Apply (L3) PO2: Review (L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply (L3) PO6: Thumb Rule PO7: Thumb Rule	3 3 3 3 3 1 1
5	11	15%	3	Evaluate	L5	PO1 PO2 PO3 PO4 PO5 PO6 PO7	PO1: Apply (L3) PO2: Review (L2) PO3: Develop (L3) PO4: Analyze (L4) PO5: Apply (L3) PO6: Thumb Rule PO7: Thumb Rule	3 3 3 3 3 1 1
	75	100%						

Justification Statements:

CO1: Understand the fundamentals, classifications, and applications of drone technology.

Action Verb: Understand (L2)

PO1 Verbs: Apply (L3) CO1 Action Verb is less than PO1 verb by one level; Therefore, correlation is moderate (2).

PO2 Verbs: Review (L2) CO1 Action Verb is equal to PO2 verb; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3) CO1 Action Verb is less than PO3 verb by one level; Therefore, correlation is moderate (2).

PO4 Verbs: Analyze (L4) CO1 Action verb is less than PO4 verb by two levels; Therefore, correlation is low (1).

PO5 Verbs: Apply (L3) CO1 Action verb is less than PO5 verb by one level; Therefore, correlation is moderate (2).

CO2: Apply drone design, fabrication, assembly, programming, and stabilization techniques using appropriate hardware and software tools.

Action Verb: Apply (L3)

PO1 Verbs: Apply (L3) CO2 Action Verb is equal to PO1 verb by; Therefore, correlation is high (3).

PO2 Verbs: Review (L2) CO2 Action Verb is greater than PO2 verb by one level; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3) CO2 Action Verb is equal to PO3 verb by; Therefore, correlation is high (3).

PO4 Verbs: Analyze (L4) CO2 Action verb is less than PO4 verb by one level; Therefore, correlation is moderate (2).

PO5 Verbs: Apply (L3) CO2 Action Verb is equal to PO5 verb; Therefore, correlation is high (3).

CO3: Apply appropriate flight modes, sensors, and control mechanisms for safe drone operation.

Action Verb: Apply (L3)

PO1 Verbs: Apply (L3) CO3 Action Verb is equal to PO1 verb by; Therefore, correlation is high (3).

PO2 Verbs: Review (L2) CO3 Action Verb is greater than PO2 verb by one level; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3) CO3 Action Verb is equal to PO3 verb; Therefore, correlation is high (3).

PO4 Verbs: Analyze(L4) CO3 Action Verb is less than PO4 verb by one level; Therefore, correlation is moderate (2).

PO5 Verbs: Apply (L3) CO3 Action Verb is equal to PO5 verb; Therefore, correlation is high (3).

CO4: Analyze drone technologies for commercial applications in logistics, agriculture, insurance, infrastructure inspection, and aerial imaging.

Action Verb: Analyze (L4)

PO1 Verbs: Apply (L3) CO4 Action Verb is greater than PO1 verb by one level; Therefore, correlation is high (3).

PO2 Verbs: Review (L2) CO4 Action Verb is greater than PO2 verb by two levels; Therefore, correlation is high (3).

PO3 Verbs: Develop (L3) CO4 Action Verb is greater than PO3 verb by one level; Therefore, correlation is high (3).

PO4 Verbs: Analyze (L4) CO4 Action Verb is equal to PO4 verb by; Therefore, correlation is high (3).

PO5 Verbs: Apply (L3) CO4 Action Verb is greater than PO5 verb by one level; Therefore, correlation is high (3).

PO6 Verbs: Using thumb rule, CO4 correlates PO6 as low (1).



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AK23 Regulations

PO7 Verbs: Using thumb rule, CO4 correlates PO7 as low (1).

CO5: Evaluate future drone technologies, safety regulations, licensing requirements, and autonomous systems.

Action Verb: Evaluate (L5)

PO1 Verbs: Apply (L3) CO5 Action Verb is greater than PO1 verb by two levels; Therefore, correlation is high (3).

PO2 verbs: Review (L2) CO5 Action Verb greater than PO2 verb by three levels; Therefore, correlation is high (3).

PO3 verbs: Develop (L3) CO5 Action Verb greater than PO3 verb by two levels; Therefore, correlation is high (3).

PO4 Verbs: Analyze (L4) CO5 Action Verb is greater than PO4 verb by one level; Therefore, correlation is high (3).

PO5 verb: Apply (L3) CO5 Action Verb is greater than PO5 verb by two levels; Therefore, correlation is high (3).

PO6 Verb: Using thumb rule, CO5 correlates PO6 as low (1).

PO7 Verb: Using thumb rule, CO5 correlates PO7 as low (1).



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AK23 Regulations

Course Code	Year & Sem	Gender Sensitization (Common to All Branches of Engineering)	L	T/CLC	P	C
23AMCMB01	IV-I		2	0	0	0

Course Outcomes: After the completion of the course Student should be able to

CO1: Understand the fundamental concepts, construction, and socialization of gender in the context of gender identity for social development.

CO2: Apply gender roles, relationships, discrimination in the context of sex selection, declining sex ratio for addressing social and demographic consequences.

CO3: Analyze the division, valuation of labour in the context of unrecognized work and gender development for awareness of gender-related issues in society

CO4: Analyze the gender-based violence in the context of its causes, impacts and consequences considering the human rights perspective.

CO5: Analyze gender-sensitive approaches by integrating gender-sensitive language and just relationship principles for media and everyday life.

CO	Action Verb	Knowledge Statement	Condition	Criteria	Blooms level
CO1	Understand	the fundamental concepts, construction, and socialization	in the context of gender identity	for social development.	L2
CO2	Apply	gender roles, relationships, discrimination	in the context of sex selection	for addressing social and demographic consequences.	L3
CO3	Analyze	the division, valuation of labour	in the context of unrecognized work and gender development	for awareness of gender-related issues in society	L4
CO4	Analyze	the gender-based violence	in the context of its causes, impacts and consequences	considering the human rights perspective.	L4
CO5	Analyze	gender-sensitive approaches	by integrating gender-sensitive language and just relationship principles	for media and everyday life	L4

Unit-1 UNDERSTANDING GENDER

Introduction: Definition of Gender-Basic Gender Concepts and Terminology-Exploring Attitudes towards Gender-Construction of Gender-Socialization: Making Women, Making Men - Preparing for Womanhood. Growing up Male. First lessons in Caste.

Unit-2 GENDER ROLES AND RELATIONS

Two or Many? -Struggles with Discrimination-Gender Roles and Relations-Types of Gender Roles- Gender Roles and Relationships Matrix-Missing Women-Sex Selection and its Consequences- Declining Sex Ratio- Demographic Consequences-Gender Spectrum -

Unit-3 GENDER AND LABOUR

Division and Valuation of Labour-Housework: The Invisible Labor- —My Mother doesn't Work. —Share the Load. —Work: Its Politics and Economics -Fact and Fiction- Unrecognized and Unaccounted work -Gender Development Issues-Gender, Governance and Sustainable Development-Gender and Human Rights-Gender and Mainstreaming

Unit-4 GENDER-BASED VIOLENCE

The Concept of Violence- Types of Gender-based Violence-Gender-based Violence from a Human Rights Perspective-Sexual Harassment - Domestic Violence - Different forms of violence against women - Causes of violence, impact of violence against women - Consequences of gender-based violence

Unit-5 GENDER AND CULTURE

Gender and Film-Gender and Electronic Media-Gender and Advertisement-Gender and Popular Literature- Gender Development Issues-Gender Issues- Gender Sensitive Language- Just Relationships

Textbooks:

. Suneetha, Uma Bhugubanda, et al. *Towards a World of Equals: A Bilingual Textbook on Gender*, Telugu Akademi, Telangana, 2015.

utler, Judith. *Gender Trouble: Feminism and the Subversion of Identity*. UK Paperback Edn. March 1990.

Reference Books:



tatt, Robin and Massood, Nazia, *Broken Mirrors: The dowry Problems in India*, London : Sage Publications, 2011
att, R. and Kornberg, J.(eds), *Women in Developing Countries, Assessing Strategies for Empowerment*, London: Lynne Rienner Publishers, 2002
rush, Lisa D., *Gender and Governance*, New Delhi, Rawat Publication, 2007
ngh, Direeti, *Women and Politics World Wide*, New Delhi, Axis Publications, 2010
aj Pal Singh, Anupama Sihag, *Gender Sensitization: Issues and Challenges* (English, Hardcover), Raj Publications, 2019.
.Revathy& Murali, Nandini, *A Life in Trans Activism*(Lakshmi Narayan Tripathi). The University of Chicago Press, 2016.

Online Learning Resources:

1.Understanding Gender:
chrome-
extension://kdpelmjpfafjppnhbloffcjpeomlnpah/https://www.arvindguptatoys.com/arvindgupta/k
amla-gender1.pdf
https://onlinecourses.swayam2.ac.in/nou24_hs53/preview
2.Gender Roles and Relations
<https://www.plannedparenthood.org/learn/gender-identity/sex-gender-identity/what-are-gender-roles-and-stereotypes>
<https://www.verywellmind.com/understanding-gender-roles-and-their-effect-on-our-relationships-7499408>
https://onlinecourses.swayam2.ac.in/cec23_hs29/preview
3.Gender and Labour
<https://www.economicsobservatory.com/what-explains-the-gender-division-of-labour-and-how-can-it-be-redressed>
https://onlinecourses.nptel.ac.in/noc23_mg67/preview
4.Gender-Based Violence
https://eige.europa.eu/gender-based-violence/what-is-gender-based-violence?language_content_entity=en
<https://www.worldbank.org/en/topic/socialsustainability/brief/violence-against-women-and-girls>
https://onlinecourses.swayam2.ac.in/nou25_ge38/preview
5.Gender And Culture
<https://gender.study/psychology-of-gender/culture-impact-gender-roles-identities/>
<https://sociology.iresearchnet.com/sociology-of-culture/gender-and-culture/>
<https://archive.nptel.ac.in/courses/109/106/109106136/>
<http://www.thealternative.in/lifestyle/i-fought-for-my-lifeand-won-sohaila-abdul/>

Mapping of course outcomes with program outcomes

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1						2		2					
CO2						2		2					
CO3						3		3					
CO4						3		3					
CO5						3		3					

Correlation matrix

Unit No.	CO					Program Outcome (PO)	PO(s): Action Verb and BTL (for PO1 to PO11)	Level of Correlation (0-3)
	Lesson plan (Hrs)	%	Correlation	Co's Action verb	BTL			
1	6	20%	3	Understand	L2	PO6, PO8	PO6: Thumb Rule PO8: Thumb Rule	2 2
2	6	20%	2	Apply	L3	PO6, PO8	PO6: Thumb Rule	3 3



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							PO8: Rule	Thumb	
3	6	20%	2	Analyze	L4	PO6, PO8	PO6: Rule	Thumb	3
							PO8: Rule	Thumb	3
4	6	20%	2	Analyze	L4	PO6, PO8	PO6: Rule	Thumb	3
							PO8: Rule	Thumb	3
5	6	20%	3	Analyze	L4	PO6, PO8	PO6: Rule	Thumb	3
							PO8: Rule	Thumb	3
	30	100%							

Justification Statements:

CO1: Understand the fundamental concepts, construction, and socialization of gender in the context of gender identity for social development

Action Verb: Understand (L2)

PO6 Verbs: Using Thumb Rule, CO1 correlates to PO6 as moderate (2).

PO8 Verbs: Using Thumb Rule, CO1 correlates to PO8 as moderate (2).

CO2: Apply gender roles, relationships, discrimination in the context of sex selection, declining sex ratio for addressing social and demographic consequences.

Action Verb: Apply (L4)

PO6 Verbs: Using Thumb Rule, CO2 correlates to PO6 as high (3).

PO8 Verbs: Using Thumb Rule, CO2 correlates to PO8 as high (3).

CO3: Analyze the division, valuation of labour in the context of unrecognized work and gender development for awareness of gender-related issues in society

Action Verb: Analyze (L4)

PO6 Verbs: Using Thumb Rule, CO3 correlates to PO6 as high (3).

PO8 Verbs: Using Thumb Rule, CO3 correlates to PO8 as high (3).

CO4: Analyze the gender-based violence in the context of its causes, impacts and consequences considering the human rights perspective.

Action Verb: Analyze (L4)

PO6 Verbs: Using Thumb Rule, CO4 correlates to PO6 as high (3).

PO8 Verbs: Using Thumb Rule, CO4 correlates to PO8 as high (3).

CO5: Analyze gender-sensitive approaches by integrating gender-sensitive language and just relationship principles for media and everyday life.

Action Verb: Analyze (L4)

PO6 Verbs: Using Thumb Rule, CO5 correlates to PO6 as high (3).

PO8 Verbs: Using Thumb Rule, CO5 correlates to PO8 as high (3).