SRI VENKATESWARA COLLEGE OF ENGINEERING

(An Autonomous Institution, Affiliated to Anna University, Chennai – 600 025)

B.E. Mechanical and Automation Engineering

CURRICULUM AND SYLLABUS

REGULATION – 2022

CHOICE BASED CREDIT SYSTEM

Curriculum Revision No.	**00**	Board of Studies recommendation date	**06.10.2022 & 12.04.2023**	Academic Council Approved date	**08.10.2022 & 21.04.2023**
Salient Points of the revision	1	Not Applicable – New Program			
	2	Not Applicable – New Program			
	3	Not Applicable – New Program			
	4	Not Applicable – New Program			
	5	Not Applicable – New Program			

SRI VENKATESWARA COLLEGE OF ENGINEERING

(An Autonomous Institution, Affiliated to Anna University, Chennai – 600 025)

REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM

B.E. MECHANICAL AND AUTOMATION ENGINEERING

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

1. Secure professional career in mechanical industries, government, and defense sectors.
2. Offer solutions to problems associated with robotics and automation systems by effectively employing computational and analytical tools.
3. Advance their professional knowledge and expertise by pursuing higher education and lifelong learning.
4. Become job creators and global contributors by taking up entrepreneurship in the field of mechanical and automation engineering.

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The engineer and society**: Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and sustainability**: Understand the impact of professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9. **Individual and teamwork**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Apply domain knowledge of mathematics and mechanical engineering concepts to provide solutions for current industrial challenges.
2. Model, programme and build robotics and automation systems that are cost effective, environment friendly and productive to solve industrial and societal problems using advanced tools and techniques.

PEO's–PO's & PSO's MAPPING:

POs	PEOs			
	I	II	III	IV
1	✓	✓	✓	✓
2	✓	✓	✓	
3	✓	✓	✓	
4			✓	
5		✓	✓	
6		✓	✓	
7			✓	
8			✓	
9			✓	
10	✓	✓	✓	✓
11			✓	
12				
PSOs				
1	✓	✓		
2	✓	✓	✓	

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REGULATIONS 2022

CHOICE BASED CREDIT SYSTEM

B.E. MECHANICAL AND AUTOMATION ENGINEERING

CURRICULUM

SEMESTER I

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
1.	IP22151	Induction Program	-	-	-	-	-	-	-	-
Theory Courses										
2.	HS22151	Tamil Language and Heritage of Tamil Society **(Common to all Branches)**	HS	1	0	0	1	1	Nil	F
3.	HS22152	Communicative English **(Common to all Branches)**	HS	3	0	0	3	3	Nil	F
4.	MA22151	Applied Mathematics – I **(Common to all Branches except MR)**	BS	3	1	0	4	4	Nil	F
5.	PH22152	Engineering Physics **(Common to AE, CE, ME, MN, MR)**	BS	3	0	0	3	3	Nil	F
6.	CY22152	Engineering Chemistry **(Common to AE, ME, MN)**	BS	3	0	0	3	3	Nil	F
7.	CS22151	Programming in C **(Common to ME and MN)**	ES	3	0	0	3	3	Nil	F
8.	ME22101	Engineering Drawing **(Common to ME, MN, MR)**	ES	2	0	2	3	4	Nil	F
Practical Courses										
9.	PH22161	Physics Laboratory **(Common to all Branches except BT)**	BS	0	0	2	1	2	Nil	F
10.	CY22161	Chemistry Laboratory **(Common to all Branches except AD, CS, IT)**	BS	0	0	2	1	2	Nil	F
11.	CS22161	Programming in C Laboratory **(Common to ME and MN)**	ES	0	0	3	1.5	3	Nil	F
			Total	**18**	**1**	**9**	**23.5**	**28**		

SEMESTER II

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	HS22251	Science and Technology in Ancient Tamil Society **(Common to all Branches)**	HS	2	0	0	2	2	Nil	F
2.	HS22252	Technical English **(Common to all Branches)**	HS	3	0	0	3	3	Nil	F
3.	MA22251	Applied Mathematics – II **(Common to all Branches except MR)**	BS	3	1	0	4	4	Nil	F
4.	PH22253	Engineering Materials **(Common to AE, ME, MN)**	BS	3	0	0	3	3	Nil	F
5.	ME22201	Engineering Mechanics **(Common to ME, MN, MR)**	ES	2	1	0	3	3	Nil	F
6.	EE22151	Basic Electrical and Electronics Engineering **(Common to all Branches except CH, EE, EC)**	ES	3	0	0	3	3	Nil	F
Practical Courses										
7.	ME22211	Production Drawing Laboratory **(Common to ME and MN)**	ES	0	0	4	2	4	Nil	F
8.	EE22111	Basic Electrical and Electronics Engineering Laboratory **(Common to all Branches except EC)**	ES	0	0	2	1	2	Nil	F
			Total	**16**	**2**	**6**	**21**	**24**		

SEMESTER III

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	MA22355	Partial Differential Equations and Numerical Methods	BS	3	1	0	4	4	Nil	F
2.	MN22301	Introduction to Industrial Automation	PC	3	0	0	3	3	Nil	F
3.	ME22302	Mechanics of Materials **(Common to ME and MN)**	PC	2	1	0	3	4	ME22201	F
4.	MN22302	Theory of Machines	PC	3	1	0	4	4	Nil	F
5.	MN22303	Manufacturing Technology	PC	3	0	0	3	3	Nil	F
6.	EE22359	Electrical Drives and Controls: Theory and Practices **(Common to ME and MN)**	ES	2	0	2	3	4	Nil	F
Practical Courses										
7.	ME22313	Manufacturing Technology Laboratory	PC	0	0	3	1.5	3	Nil	F
8.	ME22314	Material Testing Laboratory	PC	0	0	3	1.5	3	Nil	F
			Total	**16**	**3**	**8**	**23**	**30**		

SEMESTER IV

SL. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK				TOTAL HOURS	PREREQUISITE	POSITION
				L	T	P	C			
Theory Courses										
1.	GE22451	Environmental Sciences & Sustainability **(Common to all Branches)**	ES	3	0	0	3	3	Nil	F
2.	MN22401	Design of Machine Elements	PC	3	1	0	4	4	ME22302	F
3.	MN22402	Fluid Mechanics and Thermal Science	PC	3	1	0	4	4	Nil	F
4.	MN22403	Operations Research and Management	PC	3	1	0	4	4	Nil	F
4.	MN22408	Hydraulics and Pneumatics for Automation: Theory and Practices **(Common to all MN & ME)**	PC	2	0	2	3	4	Nil	F
6.	MN22409	Metrology and Instrumentation: Theory and Practices	PC	2	0	2	3	4	Nil	F
Practical Courses										
7.	ME22411	Computer Aided Modelling Laboratory **(Common to ME & MN)**	PC	0	0	3	1.5	3	Nil	F
8.	ME22412	Fluid and Thermal Engineering Laboratory **(Common to ME & MN)**	PC	0	0	3	1.5	3	Nil	F
			Total	**17**	**3**	**11**	**24.0**	**31**		

SYLLABUS
SEMESTER I

HS22151 **தமிழ் மொழியும் தமிழர் மரபும்**
Tamil Language and Heritage of Ancient Tamil Society
(Common to all Branches)

L	T	P	C
1	0	0	1

பாடத்தின் நோக்கங்கள்:

1. தமிழ் மொழியின் தோற்றம் பற்றியும், திணை கருத்துக்கள் வாயிலாக வாழ்வியல் முறைகளை பற்றியும் கற்றுக் கொள்வார்கள்.
2. இந்திய தேசிய சுதந்திர இயக்கத்தில் தமிழர்களின் பங்களிப்பு மற்றும் தமிழர்களின் மேலாண்மை முறைகளை பற்றியும் கற்றுக் கொள்வார்கள்.

அலகு 1 தமிழுக்கும் தொழில் நுட்ப கல்விக்கும் உள்ள தொடர்பு **3**

மொழி மற்றும் பாரம்பரியம்: இந்தியாவில் உள்ள மொழிக் குடும்பங்கள் - திராவிட மொழிகள் - தமிழ் ஒரு செம்மொழி - தமிழில் செம்மொழி இலக்கியம் - உ.வே. சுவாமிநாத ஐயர்., ஆறுமுக நாவலர் ஆகியோரின் பங்களிப்பு - தொழில் நுட்ப கல்வியில் தமிழ் மொழிக் கல்வியின் முக்கியத்துவம்.

LANGUAGE AND HERITAGE: Language families in India – Dravidan Languages – Tamil as a Classical language – Classical Literature in Tamil – Contribution of U. Ve. Saminathaiyar. Arumuka Navalar – Importance of Tamil language in technical education.

அலகு 2 திணை கருத்துக்கள் **9**

திணை கருத்துக்கள்: ஐந்து வகை நிலங்கள், தமிழர்களின் தாவரங்கள் மற்றும் விலங்கினங்கள், கடவுள்கள், தொழில்கள் , வாழ்க்கை முறை, பண் , கூத்து , உணவு முறை - தொல்காப்பியம் மற்றும் சங்க இலக்கியங்களில் இருந்து அகம் மற்றும் புறம் கருத்து - தமிழ் அறம் கருத்து - சங்க காலத்தில் கல்வி மற்றும் எழுத்தறிவு - பண்டைய நகரங்கள் மற்றும் சங்க காலத்தில் துறைமுகங்கள் - சங்க காலத்தில் ஏற்றுமதி மற்றும் இறக்குமதி - சோழ மன்னர்களின் வெளிநாட்டு வெற்றிகள்.

THINAI CONCEPTS: Five types of lands, animals, Gods, occupation, life styles, music, dance , food style, Floara and Fauna of Tamils - Agam and puram concept from Tholkappiyam and Sangam Literature – Aram concept of Tamil – Education and Literacy during Sangam Age – Ancient cities and Ports of Sangam Age – Export and Import during Sangam Age - Overseas Conquest of Choloas.

அலகு 3 தமிழரின் மரபு 3

இந்திய தேசிய சுதந்திர இயக்கம் மற்றும் இந்திய கலாச்சாரத்திற்கு தமிழர்களின் பங்களிப்பு: சுப்ரமணிய பாரதி, வாஞ்சிநாதன், சுப்பிரமணிய சிவா, வீரபாண்டிய கட்டபொம்மன், வா.. ஊ சிதம்பரம் பிள்ளை, தீரன் சின்னமலை, மருது பாண்டிய சகோதரர்கள், பூலி தேவர், திருப்பூர் குமரன்,

வீர மங்கை வேலுநாச்சியார் - தமிழர் இலக்கியங்களில் மேலாண்மை **கருத்துக்கள் (கி. மு. 500 முதல் கி. பி 200 வரை)** – அகநானூறு, புறநானூறு, திருக்குறள் ஆகியவற்றில் மேலாண்மைக் கருத்துகள்.

CONTRIBUTION OF TAMILS TO INDIAN NATIONAL FREEDOM MOVEMENT AND INDIAN CULTURE: Contributions of Subramanya Bharathi, Vanchinathan, Subramaniya Siva, Veerapandiya Kattabomman, V O Chidambaram Pillai, Dheeran Chinnamalai, The Maruthu Pandiyar, Puli Thevar, Tiruppur Kumaran, Veera Mangai Velunachiyar.

மொத்தம்: 15 காலங்கள்

பா .வெ . எண்	பாட திட்டத்தின் வெளிப்பாடு
CO1	மாணவர்கள் தமிழ் மொழி தோற்றம் பற்றி தெரிந்து கொள்வார்கள்
CO2	தமிழர்களின் வாழ்வியல் முறைகளை தெரிந்து கொள்வார்கள்
CO3	தமிழர்களின் சுதந்திர போராட்ட வீரர்களை பற்றியும், மேலாண்மை முறைகளை பற்றியும் தெரிந்து கொள்வார்கள்

பாட நூல்கள்:

1. பொன். முத்துகுமாரன் (2002), **"தமிழ் மரபு"**, காந்தளகம், 68, அண்ணா சாலை, சென்னை 600 002.
2. பி. டி ஸ்ரீனிவாச ஐயங்கார் ***(தமிழக்கமும் திறனாய்வும்)*** புலவர் கா. கோவிந்தன் (1988), "**தமிழர் வரலாறு (முதல் பகுதி)**", திருநெல்வேலி தென்னிந்திய சைவ சித்தாந்த நூற்பதிப்பு கழகம் ,154, TTK சாலை, சென்னை 18.
3. டாக்டர் கே கே பிள்ளை (2009), **"தமிழக வரலாறு மக்களும் பண்பாடும்"**, உலக தமிழாராய்ச்சி நிறுவனம், தரமணி , சென்னை 600113.
4. முனைவர். ச. இராஜேந்திரன் (2004), "**தமிழில் சொல்லாக்கம்**", தஞ்சாவூர் தமிழ் பல்கலைக் கழகம் வெளியீடு.

HS22152 **COMMUNICATIVE ENGLISH**
(Common to all Branches)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Enable learners to interact fluently on everyday social contexts.
2. Train learners to engage in conversations in an academic/scholarly setting.
3. Instill confidence in learners to overcome public speaking barriers.
4. Develop learners' ability to take notes and in the process, improve their listening skills
5. Enhance learners' reading skill through reading text passages for comprehension and contemplation.
6. Improve learners' skills to write on topics of general interest and drafting correspondences for general purposes

UNIT I **19**

Listening - short video clips - conversational scenes form movies, celebrities' speeches/interviews. Speaking - several ways of introducing oneself at several situations, introducing others at several situations, inviting people for several occasions, describing people and their places. Reading - short comprehension passages - making inferences, critical analysis. Writing - completing the incomplete sentences - developing hints from the given information. Grammar - Why-Questions and Yes or No questions - Parts of speech. Vocabulary development - prefixes - suffixes - articles - countable / uncountable nouns.

UNIT II **9**

Listening - customer care voice files, short narratives - identifying problems and developing telephone etiquettes. Speaking - speaking over skype/WhatsApp, making business calls, making self- recorded informative videos, inquiring about a concept/activity, describing a concept/activity. Reading - reading the headlines on news magazines - slogans and taglines from advertisements. Writing - free writing - writing - headlines, slogans and taglines individual inspirations. Grammar - conjunctions, idioms, phrases, quotes. Vocabulary development - guessing the meanings of words in various different contexts

UNIT III **9**

Listening - courtroom scenes from movies, debates and talks from news channels, notes taking. Speaking - language and tone for arguments, discussion, deliberation, contemplation, expressing opinions, reacting to different situations in an alien country. Reading - language used in instruction manuals of household appliances, cookery and other basic instructions. Writing- understanding the structure of texts - use of reference words, discourse markers-coherence, rearranging the jumbled sentences. Grammar - adjectives - degrees of comparison, framing direct and indirect questions. Vocabulary development - concise approach, single word substitution.

UNIT IV **9**

Listening - Sports commentaries, advertisements with users' criticisms; Speaking - for social causes, for promoting a concept, negotiating and bargaining; Reading - review of a product, movie, movement or a system; Writing - writing for advertisements, selling a product; Grammar - Tenses - Simple Past, Present and Future, Continuous - Past, Present and Future; Vocabulary Development - synonyms, antonyms and phrasal verbs.

UNIT V **9**

Listening - video lectures, video demonstration of a concept; Speaking - presenting papers/concepts, delivering short speeches, discourses on health, suggesting natural home remedies, cleanliness, civic

sense and responsibilities; Reading - columns and articles on home science; Writing - correspondences of requests, basic enquiry/observation and basic complaints; Grammar - modal verbs, perfect tenses - Vocabulary development - collocations.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Acquire** adequate vocabulary for effective communication	3
CO2	**Listen** to formal and informal communication and read articles and infer meanings from specific contexts from magazines and news papers.	3
CO3	**Participate** effectively in informal/casual conversations; introduce themselves and their friends and express opinions in English.	4
CO4	**Comprehend** conversations and short talks delivered in English.	6
CO5	**Write** short write-ups and personal letters and emails in English	6

REFERENCES:

1. Department of English, Anna University, "Mindscapes: English for Technologists and Engineers". Orient Black Swan, Chennai, 2017.
2. Downes, Colm, “Cambridge English for Job-hunting", Cambridge University Press, New Delhi. 2008.
3. Murphy, Raymond, "Intermediate English Grammar with Answers", Cambridge University Press 2000.
4. Thomson, A.J., "Practical English Grammar 1 & 2", Oxford, 1986.

E-RESOURCES:

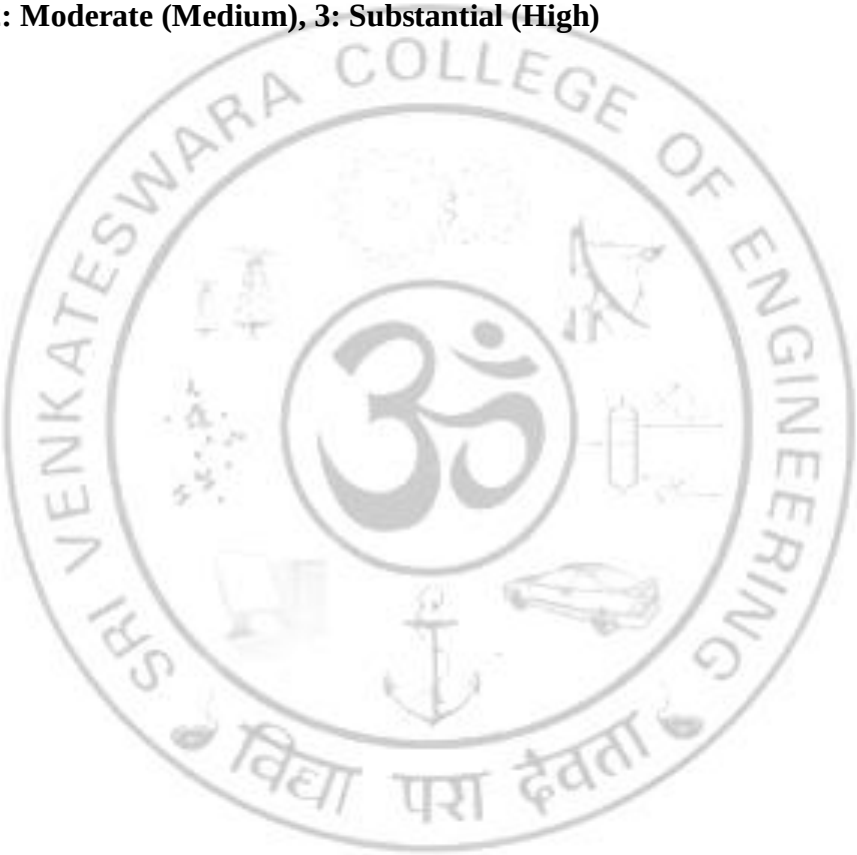
1. http://www.usingenglish.com
2. http://www.uefap.com3
3. https://owl.english.purdue.edu/owl/
4. www.learnenglishfeelgood.com/esl-printables-worksheets.html

SOFTWARE:

1. Face2Face Advance – Cambridge University Press, 2014
2. English Advance Vocabulary- Cambridge University Press
3. IELTS test preparation – Cambridge University Press 2017
4. Official Guide to the TOEFL Test With CD-ROM, 4th Edition
5. CAMBRIDGE Preparation for the TOEFL TEST- Cambridge University Press, 2017

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1										3				
2										3				
3										3				
4										3				
5										3				

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)



MA22151 **APPLIED MATHEMATICS I**
(Common to all Branches except MR)

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. Compute Eigen values and Eigen vectors and use in diagonalization and in classifying real quadratic forms.
2. Study differential calculus and its applications to relevant Engineering problems.
3. Compute derivatives using the chain rule or total differentials.
4. Understand the rotation of two-dimensional geometry using definite integrals.
5. Acquaint with the Mathematical tools needed in evaluating multiple integrals and their usage.

UNIT I MATRICES **12**

Eigen values and Eigen vectors of a real matrix - Characteristic equation - Properties of Eigen values and Eigen vectors - Statement and Applications of Cayley-Hamilton Theorem - Diagonalization of matrices - Reduction of a quadratic form into canonical form by orthogonal transformation - Nature of quadratic forms.

UNIT II APPLICATION OF DIFFERENTIAL CALCULUS **12**

Curvature and radius of Curvature - Centre curvature - Circle of curvature - Evolutes - Envelopes - Evolute as Envelope of Normals.

UNIT III DIFFERENTIAL CALCULUS FOR SEVERAL VARIABLES **12**

Limits and Continuity - Partial derivatives - Total derivatives - Differentiation of implicit functions - Jacobians and properties - Taylor's series for functions of two variables - Maxima and Minima of functions of two variables - Lagrange's method of undetermined multipliers.

UNIT IV APPLICATION OF DEFINTE INTEGRALS **12**

Integration by Parts - Bernoulli's formula for integration - Definite integrals and its Properties - Solids of Revolution - Disk Method - Washer Method- Rotation about both x and y axis and Shell method.

UNIT V MULTIPLE INTEGRALS **12**

Double integrals in Cartesian and polar coordinates - Change of order of integration - Area enclosed by plane curves - Change of variables in double integrals - Triple integrals - Volume of solids.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Solve** the Eigen value problems in matrices.	**3**
CO2	**Apply** the basic notion of calculus in Engineering problems and to tackle for different geometries.	**3**
CO3	**Perform** calculus for more than one variable and its applications in Engineering problems.	**3**
CO4	**Apply** definite integrals for design of three-dimensional components.	**3**
CO5	**Evaluate** multiple integral in Cartesian and polar coordinates.	**3**

TEXTBOOKS:

1. Grewal B.S., “Higher Engineering Mathematics", 44th Edition, Khanna Publishers, New Delhi, 2018.
2. Kreyszig E, "Advanced Engineering Mathematics ", 10th Edition, John Wiley, New Delhi, India, 2018.

REFERENCES:

1. Bali. N.P, and Manish Goyal, "A Text book of Engineering Mathematics", 9th Edition, Laxmi Publications Pvt. Ltd., 2014.
2. Glyn James, "Advanced Modern Engineering Mathematics", 4th Edition, Pearson Education, 2016.
3. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2013.

E-RESOURCES:

1. https://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf
2. https://www.sydney.edu.au/content/dam/students/documents/mathematics-learning-entre/integration-definite-integral.pdf
3. https://home.iitk.ac.in/~peeyush/102A/Lecture-notes.pdf

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3			2									2	
2	3	2		2									2	
3	3	2		2									2	
4	3			1									2	
5	3			2									2	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

PH22152 **ENGINEERING PHYSICS**
(Common to AE, CE, ME, MN, MR)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To enhance the fundamental knowledge in Physics and its applications relevant to Streams of Engineering.

UNIT I MECHANICS **9**

Moment of inertia (M.I) - Radius of gyration - Theorems of M. I - M.I of circular disc, solid cylinder, hollow cylinder, solid sphere and hollow sphere - K.E of a rotating body - M.I of a diatomic molecule - Rotational energy state of a rigid diatomic molecule - centre of mass - conservation of linear momentum - Relation between Torque and angular momentum - Torsional pendulum.

UNIT II PROPERTIES OF MATTER AND THERMAL PHYSICS **9**

Fluid - definition, distinction between solid and fluid - Units and dimensions - Properties of fluids - density, specific weight, specific volume, specific gravity, viscosity, compressibility, vapour pressure, capillarity and surface tension - Fluid statics: concept of fluid static pressure, absolute and gauge pressures - pressure measurements by manometers-forces on planes - centre of pressure - buoyancy and floatation.

Modes of heat transfer - thermal conductivity - Newton's law of cooling - Linear heat flow - Lee's disc method - Radial heat flow - Rubber tube method - conduction through compound media (series and parallel).

UNIT III ACOUSTICS AND ULTRASONICS **9**

Classification of Sound- decibel- Weber–Fechner law - Sabine's formula- derivation using growth and decay method - Absorption Coefficient and its determination –factors affecting Acoustics of buildings and their remedies. Production of Ultrasonics by Magnetostriction and Piezoelectric methods - Acoustic grating - Non-Destructive Testing - pulse echo system through transmission and reflection modes - A, B and C - scan displays, medical applications - Sonogram.

UNIT IV PHOTONICS AND FIBER OPTICS **9**

Photonics: population of energy levels, Einstein's A and B coefficients derivation - resonant cavity, optical amplification (qualitative) - Nd-YAG laser - CO_2 Laser - Applications. Fiber optics: principle, numerical aperture and acceptance angle - types of optical fibres (material, refractive index, and mode) - losses associated with optical fibers - Fiber optic communication - fibre optic sensors: pressure and displacement- Endoscope.

UNIT V CRYSTAL PHYSICS **9**

Single crystalline, polycrystalline and amorphous materials - single crystals: unit cell, crystal systems, Bravais lattices, directions and planes in a crystal, Miller indices - interplanar distances - coordination number and packing factor for SC, BCC, FCC, HCP and diamond structure (qualitative) – crystal imperfections: point defects, line defects - Burger vectors, stacking fault.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Gain knowledge in Mechanics	**2**
CO2	Evaluate the concepts of properties of matter and thermal physics.	**3**
CO3	Learn to solve the issues related to defects in the buildings due to acoustic design	**3**

	and the significance of ultrasonic waves.	
CO4	Develop an understanding about photonics and Fiber Optic communication system.	**2**
CO5	Classify and demonstrate the fundamentals of crystals and their defects.	**3**

TEXTBOOKS:

1. Gaur R.K. and Gupta S.L, "Engineering Physics", Dhanput Publications, 2015.
2. Shatendra Sharma and Jyotsna Sharma, "Engineering Physics", Pearson, 2006.
3. Rajendran V, "Engineering Physics", Tata McGraw Hill, 2009.
4. Arumugam M, "Materials Science", Anuradha Publications, 2015

REFERENCES:

1. David Halliday, Robert Resnick, Jearl Walker, "Principles of Physics", 10th Edition, Wiley,2015.
2. Peter Atkins and Julio De Paula, "Physical Chemistry", 10th Edition, Oxford University Press,2014.
3. Arthur Beiser, Shobhit Mahajan, Rai Choudhury S, "Concepts of Modern Physics", 7th Edition, McGraw Hill Education, 2017.
4. Raghavan V, "Materials Science and Engineering", PHI Learning Pvt. Ltd., 2010.

COURSE ARTICULATION MATRIX:

COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2		2						1			3	2
2	3	2		2						1		2	2	2
3	3		2		3	2	1			1				
4	3		2		3	2	1			1		2	2	2
5	3	2	2							1			1	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

CY22152 **ENGINEERING CHEMISTRY**
(Common to AE, ME, MN)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To make the students to understand the importance of electrochemistry.
2. To appreciate the concepts of photochemistry and spectroscopy.
3. To impart knowledge on nanotechnology.
4. To understand the applications of engineering materials.
5. To familiarize the manufacture of fuels.

UNIT I ELECTROCHEMISTRY 9

Electrodes and electrochemical cells - electrode potential, standard electrode potential, single electrode potential and its determination, types of electrodes - calomel, quinhydrone and glass electrode. Nernst equation - determination of pH of a solution by using quinhydrone and glass electrode. Electrochemical series and its applications. Batteries - Primary (dry battery) and secondary batteries (Lead - acid storage)

UNIT II PHOTOCHEMISTRY 9

Laws of photochemistry - Grotthuss-Draper law, Stark-Einstein law and Lambert Beer Law - determination iron by spectrophotometer. Quantum efficiency - Photo physical processes - internal conversion, inter-system crossing, fluorescence, phosphorescence and photo-sensitization-quenching of fluorescence and its kinetics, Stern-Volmer relationship. Applications of photochemistry.

UNIT III NANOCHEMISTRY 9

Basics and scale of nanotechnology, different classes of nanomaterials, Distinction between molecules, nanoparticles and bulk materials; size-dependent properties. Synthesis of nanomaterials, fabrication (lithography) and its applications - Basics of nanophononics and quantum confined materials (surface plasmon resonance).

UNIT IV ENGINEERING MATERIALS 9

Abrasives: definition, classification, grinding wheel, abrasive paper and cloth. Refractories: definition, characteristics, classification, properties - refractoriness and RUL, dimensional stability, thermal spalling, thermal expansion, porosity; Manufacture of alumina, magnesite and silicon carbide, Lubricants – classification, properties and applications. Basics of composite materials, properties and applications.

UNIT V FUELS AND COMBUSTION 9

Fuel: Introduction - classification of fuels- calorific value - higher and lower calorific values - analysis of coal (proximate and ultimate) - carbonization - manufacture of metallurgical coke (Otto Hoffmann method) - petroleum - refining - manufacture of synthetic petrol (Bergius process)- knocking - octane number - diesel oil - cetane number - natural gas - compressed natural gas (CNG) - liquefied petroleum gases (LPG) - producer gas - water gas. Combustion of fuels: introduction - theoretical calculation of calorific value - calculation of stoichiometry of fuel and air ratio - flue gas analysis (ORSAT Method) - Uses of catalytic converters.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Identify electrochemical cells, corrosion and fundamental aspects of batteries	**2**
CO2	Interpret the photochemical reactions and make use of spectroscopic	**2**
CO3	Realize the structures, properties and applications of nanoparticles.	**2**
CO4	Acquire knowledge on the basic properties of engineering materials and its applications	**2**
CO5	Illustrate the various materials that are important both in industry and domestic	**3**

TEXTBOOKS:

1. P.C. Jain and Monica Jain, "Engineering Chemistry", Dhanpet Rai & Sons, New Delhi, 17th Edition, 2018.
2. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company, Ltd., New Delhi, 2008

REFERENCES:

1. Ozin G. A. and Arsenault A. C., "Nanochemistry: A Chemical Approach to Nanomaterials", RSC Publishing, 2005.
2. B.R. Puri, L.R. Sharma, M.S. Pathania., "Principles of Physical Chemistry", 47th edition, Vishal Publishing C., Jalandhar 2018.
3. P.L. Sony and H.M.Chawla, "Text Book of Organic Chemistry", Sultan Chand and Sons Publishers, New Delhi, 2000.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	3								3		
2	3	3				3	3					3		
3	3	3	2			3	3	3				3		
4	3	3		3			3	3				3		
5	3	3		3		3		3				3		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

CS22151 **PROGRAMMING WITH C**
(Common to ME and MN)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. Learn the basics of computers.
2. Learn the different ways of stating algorithms – step-form, Pseudocode and flow chart
3. Learn the logical operators and expressions to solve problems in engineering and real-time
4. Learn about decision type and looping type control constructs in C
5. Understand to store, manipulate and retrieve data in a single and multidimensional array
6. Understand about function and its benefits.
7. Learn to use arrays, strings, functions, pointers, structures, unions and files in C.

UNIT I INTRODUCTION **9**

Number System Conversion, Computer, Evolution of Computers, Anatomy of Computer - Hardware - Software - Data Representation, Memory Unit, Operating Systems, Computer Networks - Basic elements - Data Transmission mode – Data Transmission Media - Network Topology - Network Devices - Communication Networks (LAN,WAN,MAN), Internet – Uses –Advantages – Limitations - Services (Email, FTP, Telnet), Introduction to Programming, Algorithms and Flow Chart.

UNIT II C PROGRAMMING BASICS **9**

Introduction to 'C' programming – Developing program in C, A Simple C Program, Structure of a C program, Concept of a Variable, Data Types in C, Tokens, Operators and Expressions, Type Conversions, Input and Output functions, Control Statements – Conditional Execution and Selection – Iterative and Repetitive Execution – Nested Loops, Solving simple scientific and statistical problems.

UNIT III ARRAYS AND STRINGS **9**

One dimensional Array – Declaration - Initialization of Integer Elements - Accessing Array Elements, Searching and Sorting of array elements, Two dimensional arrays – Declaration - Initialization of Integer Elements - Accessing Array Elements, Addition, Subtraction and Multiplication of two dimensional integer elements, Strings, Arrays of strings, Solve problems with and without using string functions.

UNIT IV FUNCTIONS AND USER DEFINED DATA TYPES **9**

Concept of Function, Using Functions, Mechanism - Call by value, Call by reference, Recursion, - Structures, Unions, Enumerators.

UNIT V POINTERS AND FILES **9**

Understanding Memory Address, Address Operator, Pointers, void Pointer, NULL Pointer, Arrays and Pointers, Pointers arithmetic, Double Pointers, Using Files in C, Working with Text Files, Sequential and Random Access to Files.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Apply various problem-solving techniques and represent solutions in the form of algorithms and flow charts.	**2**
CO2	Able to write C programs using the control statements of C language for simple	**2**
CO3	Develop programs using of array and string operations to solve problems.	**2**

CO4	Create user-defined functions , structures and unions to perform a task.	**2**
CO5	Use file operations to store and retrieve data	**1**

TEXTBOOKS:

1. Pradip Dey, Manas Ghosh, "Programming in C", First Edition, Oxford University Press, 2018.

REFERENCES:

1. Ashok N Kamthane, "Programming in C", Third Edition, Pearson, 2015
2. Kernighan, B.W and Ritchie, D.M, "The C Programming language", 2nd Edition, Pearson Education, 2015.
3. Yashavant P. Kanetkar. "Let Us C", BPB Publications, 2011.
4. Paul J Deitel, Dr. Harvey M. Deitel, "C How to Program", 7th Edition, Pearson Education, 2016.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	2	3	3	1							1			
2	1	1	2	1	1									
3	1		2	1										
4	1		2	1										
5	1		2	1										

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22101 **ENGINEERING DRAWING**
(Common to ME, MN, MR)

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. This course will introduce students to build their ability to read drawings and interpret the position and form of simple geometries.

CONCEPTS AND CONVENTIONS AND GEOMETRIC CONSTRUCTION

(Not for Examination)

Importance of drawing in engineering applications - Use of drafting instruments - BIS conventions and specifications - Size, layout and folding of drawing sheets - Lettering and dimensioning. Geometric construction - to draw perpendiculars, parallel lines, divide a line and circle, to draw equilateral triangle, square, regular polygons.

UNIT I CYCLOIDAL CURVES, INVOLUTE AND PROJECTIONS OF POINTS, LINES **12**

Basic construction of cycloid, epicycloid and hypocycloid - Drawing of tangents and normal to the above curves. Construction of involutes of square, pentagon and circle - Drawing of tangents and normal to the above involutes.

Orthographic projection – Introduction to Principal Planes of projections - First angle projection - projection of points. Projections of straight lines (only First angle projections) inclined to both the principal planes - Determination of true lengths and true inclinations by rotating line method.

UNIT II PROJECTIONS OF PLANES AND PROJECTIONS OF SOLIDS **12**

Projections of planes (polygonal and circular surfaces) inclined to both the principal planes by rotating object method.

Projections of regular solids like prisms, pyramids, cylinder, cone when the axis is inclined to one of the principal planes and parallel to the other by rotating object method.

UNIT III SECTIONS OF SOLIDS AND DEVELOPMENT OF SURFACES **12**

Sectioning of regular solids like prisms, pyramids, cylinder and cone in vertical position when the section plane is inclined to one of the principal planes and perpendicular to the other - Drawing of sectional front and top views and true shape of section.

Development of surfaces of simple and sectioned solids - prisms, pyramids cylinders and cones.

UNIT IV ISOMETRIC PROJECTION AND INTERSECTION OF SURFACES **12**

Introduction to Pictorial Projection - Principles of isometric projection - Isometric scale - isometric projection of regular solids (prisms, pyramids, cylinder, cone), truncated solids and their combination in vertical position.

Line of intersection - Determining the line of intersection between surfaces of two interpenetrating solids with axes of the solids intersecting each other perpendicularly, using line method - Intersection of two square prisms and Intersection of two cylinders are only to be considered.

UNIT V FREE-HAND SKETCHING **12**

Free-hand sketching – Sketching procedures – Steps in sketching - Orthographic views (front, top and side views) of simple blocks from their Isometric view, Isometric view of simple blocks from their Orthographic views (front, top and side views)

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Construct Engineering curves and sketch the orthographic views of lines as per drawing standards	**3**
CO2	Draw orthographic projections of plane surfaces and simple solids in various positions	**3**
CO3	Draw the various views of sectioned solids and develop the lateral surfaces of simple solids.	**3**
CO4	Draw isometric projections of simple solids and their combinations and the orthographic projection of the intersection of surfaces of simple solids.	**3**
CO5	Sketch the orthographic projections of a given isometric view and vice versa using free hand.	**3**

TEXTBOOKS:

1. Bhatt N.D. and Panchal V.M., "Engineering Drawing", Charotar Publishing House, 53rd Edition, 2019.
2. Venugopal K. and Prabhu Raja V., "Engineering Drawing AutoCAD", New Age International, 2011.

REFERENCES:

1. Basant Agarwal and Agarwal C, "Engineering Drawing", McGraw Hill, 2nd Edition, 2019.
2. Parthasarathy N. S. and Vela Murali, "Engineering Graphics", Oxford University Press, New Delhi, 2015.
3. Shah M, and Rana B.C., "Engineering Drawing", Pearson Education, 2nd Edition, 2009.
4. Natrajan K.V., "A Text Book of Engineering Graphics", Dhanalakshmi Publishers, 2018.

E-RESOURCES:

1. https://nptel.ac.in/courses/112105294
2. https://nptel.ac.in/courses/112103019

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	1	2							1		1		
2	3	1	2							2		1		
3	3	1	2							2		1		
4	3	1	2							3		1		
5	3	1	2							3		1		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

PH22161

PHYSICS LABORATORY
(Common to all Branches except BT)

L	T	P	C
0	0	2	1

COURSE OBJECTIVES:

1. To introduce different experiments to test basic understanding of physics concepts applied in optics, thermal physics and properties of matter.

LIST OF EXPERIMENTS

1. a) Determination of Wavelength, and particle size using Laser.
   b) Determination of acceptance angle in an optical fiber.
2. Determination of velocity of sound and compressibility of liquid - Ultrasonic Interferometer.
3. Determination of wavelength of mercury spectrum - spectrometer grating.
4. Determination of thermal conductivity of a bad conductor - Lee's Disc method.
5. Determination of Young's modulus by Non uniform bending method.
6. Determination of specific resistance of a given coil of wire - Carey Foster's Bridge.
7. Determination of Rigidity modulus of a given wire - Torsional Pendulum
8. Energy band gap of a Semiconductor
9. Determine the Hysteresis loss of a given Specimen
10. Calibration of Voltmeter & Ammeter using potentiometer.

TOTAL: 30 HOURS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Analyze the physical principle involved in the various instruments; also relate the principle to new application.	**4**
CO2	Comprehend the Experiments in the areas of optics, mechanics and thermal physics to nurture the concepts in all branches of Engineering.	**3**
CO3	Apply the basic concepts of Physical Science to think innovatively and also improve the creative skills that are essential for engineering.	**3**
CO4	Evaluate the process and outcomes of an experiment quantitatively and qualitatively.	**3**
CO5	Extend the scope of an investigation whether or not results come out as expected.	**3**

REFERENCES:

1. Physics Laboratory practical manual, 1st Revised Edition by Faculty members, 2018.

COURSE ARTICULATION MATRIX:

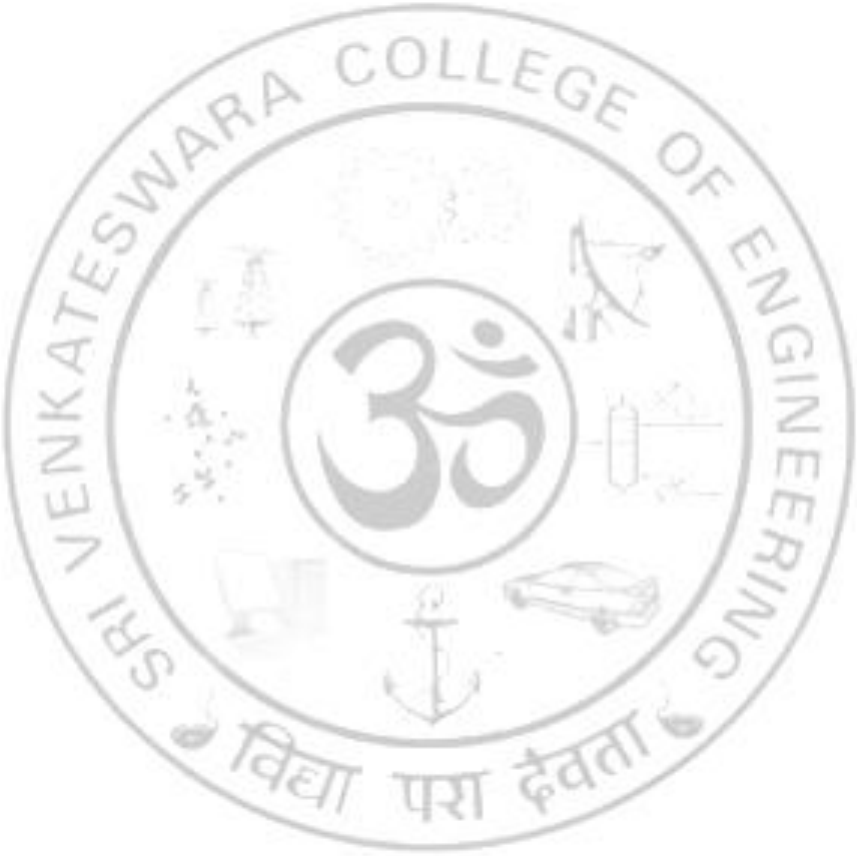
COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	2	3	2				3	1		2	1	1
2	3	3		3		2			3	1		2	1	1
3	3	3	2	3	2	2			3	1		2	1	1
4	3	3		3					3	1		2	1	1
5	3	3		3	2				3	1		2	1	1

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL. No	ITEM DESCRIPTION	QUANTITY
1.	Torsional Pendulum, stop clock, suspension metallic wire: two different thickness, two identical cylindrical mass, screwgauge, wooden scale	5
2.	Simple harmonic oscillations of cantilever: 1 meter wooden scale, G-clamp, weight hanger with slotted weights, Vernier caliper, Screw gauge, stop clock	5
3.	Non-uniform bending: 1 meter wooden scale, two-knife edges, travelling microscope, weight hanger with slotted weights, screw gauge, Vernier caliper, pin	5
4.	Uniform bending: 1meter wooden scale, two-knife edges, travelling microscope, two weight hanger with slotted weights, screw gauge, Vernier caliper, pin	5
5.	He-Ne/Diode laser (red), Greendiode laser, Grating, Screen, Iron stand (3 Nos), 1mwooden scale, thread.	5
6.	45^0 inclined glass plate set-up, two optically plane glass plates, sodium vapour lamp, travelling microscope, thin wire/thin strip of paper	5
7.	Diode laser (green or red), fiber Optic cable, movable arrangement with a screen for measuring spot size (zig), meter scale, stand	5
8.	Diode laser (green or red), iron stand, compact disc, 1m-wooden scale, screen, stand	5
9.	He-Ne laser, CCl_4 liquid or Benzene liquid, Glass cell with sample liquid (Kerosene/Toluene/Turpentine/Benzene or CCl4 liquid),RF oscillator fitted with a frequency meter, Piezoelectric crystal, Electrodes (crystal holder), Screen, iron stand (two numbers), 1m wooden scale, thread.	5
10.	Ultrasonic interferometer apparatus with high frequency wave generator, cell, micrometer, PZ crystal, water orother liquids	5
11.	Post office box, 5V power supply, thermometer, galvanometer, semiconductor (thermistor), variable temperature bath set-up (oil, temperature controller, vessel, hot plate.	5
12.	Photoelectric effect apparatus withnecessary accessories, tungsten-halogen lamp, Cesium-typevacuum photodiode.	5
13.	Michelson interferometer set-up,sodium vapour lamp and accessories	5

14.	Meld's string apparatus, thread andweight pan, weight hanger and slotted weights.	5
15.	Lattice dynamics kit with built-in audio oscillator and electrical transmission line (for mono and di- atomic lattices), general purpose CRO having XY mode.	5
16	Potentiometer	15



CY22161

CHEMISTRY LABORATORY
(Common to all Branches except AD, CS, IT)

L	T	P	C
0	0	2	1

COURSE OBJECTIVES:

1. To acquaint the students with the basic phenomenon/concepts of chemistry, the student face during course of their study in the industry and engineering field.
2. To appreciate the need for and importance of water quality parameters for industrial and domestic use.
3. To gain the knowledge on electrochemical instrumentation techniques like potential and current measuring used in electrochemistry applications
4. To impart knowledge on separation of components using paper chromatography.
5. To enhance the thinking capability about polymer and properties like molecular weight.

LIST OF EXPERIMENTS

1. Determination of DO content of water sample by Winkler's method.
2. Determination of strength of given hydrochloric acid using pH meter
3. Determination of strength of acids in a mixture using conductivity meter
4. Estimation of iron content of the water sample using spectrophotometer (phenanthroline/thiocyanate method)
5. Determination of total, temporary & permanent hardness of water by EDTA Method.
6. Estimation of iron content of the given solution using potentiometer.
7. Determination of alkalinity in water sample.
8. Determination of Single electrode potential.
9. Separation of components from a mixture of red and blue inks using Paper chromatography.
10. Determination of molecular weight of polymer by using Ostwald's/Ubbelohde viscometer.

TOTAL: 30 HOURS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Distinguish hard and soft water, solve the related numerical problems on water, purification and its significance in industry and daily life.	4
CO2	Interpret the knowledge of instruments to measure potential and current related parameters.	3
CO3	Demonstrate the basic principle for separation of components using paper chromatography.	3
CO4	Evaluate the molecular weight of polymer using Ostwald's/Ubbelohde viscometer.	3

TEXTBOOKS:

1. Furniss B.S. Hannaford A.J, Smith P.W.G and Tatchel A.R., "Vogel's "Textbook of practical organic chemistry", LBS Singapore 1994.
2. Jeffery G.H., Bassett J., Mendham J. and Denny Vogel's R.C, "Textbook of quantitative analysis chemical analysis", ELBS 5th Edition. Longman, Singapore publishers, Singapore, 1996.

REFERENCES:

1. Daniel R. Palleros, "Experimental organic chemistry" John Wiley & Sons, Inc., New York 2001.
2. Kolthoff I.M., Sandell E.B. et al. "Quantitative Chemical Analysis", McMillan, Madras 1980

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	2				3	3	3	1		1	2		
2	3	2	1			3	3	3						
3	3					3	3					2		
4	3			1		3	3	3						

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL. No	ITEM DESCRIPTION	QUANTITY
1.	Common apparatus: Pipette, Burette, conical flask, porcelain tile, dropper	30 each
2.	Iodine flask	30
3.	pH meter	5
4.	Conductivity meter	5
5.	Spectrophotometer	5
6.	Oswald/Ubbelohde Viscometer	30

CS22161 **PROGRAMMING WITH C LABORATORY**
(Common to ME and MN)

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

1. Be exposed to the syntax of C.
2. Be familiar with programming in C.
3. Learn to use arrays, strings, functions, pointers, structures and unions in C.

LIST OF EXPERIMENTS

1. Programs using IO functions and Command line arguments – scanf(), printf(), gets(), puts(), Format specifier separated with space/comma, input through terminal
2. Programs to evaluate the expression using operators in C – Arithmetic, Logical, Relational, Bitwise, conditional and sizeof() operators
3. Scientific problem solving using decision making and looping – Find largest/smallest among numbers, Even or Odd number, Factorial, Krishnamurthy number, Armstrong number, Prime number or not, Grade of students based on marks, Leap year or Not, Fibonacci series and the sum of Geometric series
4. Simple programming for one-dimensional and two-dimensional arrays – Searching, Sorting, Replacing and Two-dimensional Matrix Operations
5. Solving problems using Strings – Palindrome, Cipher a string and Sorting the names
6. Programming using user-defined functions (Pass by value and Pass by reference) – Swapping numbers, Convert a temperature from F to C, Average of marks by passing n subject marks in an array.
7. Programming using Recursion – Find factorial, sum of N numbers, sum of x^y, Number Conversion using recursion
8. Programming using Pointers – Swapping three numbers without temporary variable, double pointers
9. Programming using structures and union
10. Programming using enumerated data types
11. Programming using macros - #define, #ifdef, #if, #else and #endif
12. Programming using Files – Display the content of file and Copy from one file to other

TOTAL: 45 HOURS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Use various arithmetic and logic operators in C	**1**
CO2	Implement control statements of C language to solve scientific problems	**2**
CO3	Develop programs using array and string operations to solve problems.	**3**
CO4	Create user-defined functions to perform a task.	**3**
CO5	Develop programs using file operations to store and retrieve data	**3**

REFERENCES:

1. Pradip Dey, Manas Ghosh, "Programming in C", First Edition, Oxford University Press, 2018
2. Ashok N Kamthane, "Programming in C", Third Edition, Pearson, 2015

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	1		2	2										
2	2	1	2	2										
3	1		2	1										
4	1	1	2	2										

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENTS FOR A BATCH OF 30 STUDENTS

Sl. No	ITEM DESCRIPTION	QUANTITY
1.	Standalone Desktops with C compiler or Server with C compiler.	30

SEMESTER II

HS22251 **அறிவியல் மற்றும் தொழில் நுட்பத்தில் தமிழ்**
Science and Technology in Ancient Tamil Society
(Common to all Branches)

L	T	P	C
2	0	0	2

பாடத்தின் நோக்கங்கள்:

1. அறிவியலில் தமிழின் பயன்பாடு பற்றி தெரிந்து கொள்வார்கள்.
2. தொழில்நுட்பத்தில் தமிழ் பாரம்பரியத்தின் தாக்கம் பற்றி அறிந்து கொள்வார்கள்.

அலகு 1 அறிவியல் தமிழ் **3**

கருவி உருவாக்கம் - ஆராய்ச்சி மேம்பாடு - கல்வி வளர்ச்சி - அறிவியல் தமிழ் சொற்கள் உருவாக்கம்.

Scientific Tamil : Tool Development - Research Development - Educational Development - Scientific Tamil words Creation.

அலகு 2 தொழில் நுட்பத்தில் தமிழ் **12**

வடிவமைப்பு மற்றும் கட்டுமான தொழில்நுட்பம்: சங்க காலத்தில் கட்டுமானப் பொருட்கள் - சோழர்களின் பெரிய கோவில்கள் மற்றும் பிற வழிபாட்டு தலங்கள் - பல்லவர்களின் சிற்பங்கள் மற்றும் கோவில்கள் (மாமல்லபுரம்) - நாயக்கன் கால கோவில்கள் (மதுரை மீனாட்சி அம்மன் கோவில்), திருமலை நாயக்கர் மஹால், செட்டி நாட்டு வீடுகள்.

DESIGN AND CONSTRUCTION TECHNOLOGY: Building materials in Sangam age – Great temples of Cholas and other workship places – Sculptures and Temples of Pallavas (Mamallapuram) – Temples of Nayakas period (Madurai Meenakshi Amman temple), Thirumalai Nayakar Mahal, Chetti Nadu Houses.

உற்பத்தி தொழில்நுட்பம் : கப்பல் கட்டும் கலை, உலோகவியல் ஆய்வுகள், தங்கம், தாமிரம், இரும்பு பற்றிய அறிவு - தொல்பொருள் சான்றுகள் – சுட்டக் களிமண் மணிகள், சங்கு மணிகள், எலும்பு மணிகள்.

MANUFACTURING TECHNOLOGY: Art of Ship building, Metallurgical studies, Knowledge about Gold, Copper, Iron – Archeological evidences – Terracotta beads, Shell beads, Bone beads.

விவசாயம் மற்றும் நீர்ப்பாசன தொழில்நுட்பம் : அணைகள், ஏரிகள், குளங்கள், மதகுகள், சோழர் கால குமுழி தூம்பு ஆகியவற்றின் முக்கியத்துவம் - கால்நடை பராமரிப்பு, கால்நடைகளின் பயன்பாட்டிற்காக வடிவமைக்கப்பட்ட கிணறுகள். விவசாயம் மற்றும் வேளாண் செயலாக்கம் - கடல் பற்றிய அறிவு - மீன்பிடித்தல், முத்து குளித்தல், சங்கு சேகரித்தல்.

AGRICULTURE AND IRRIGATION TECHNOLOGY: Dams, Tank, ponds, sluice, Significance of Kumuzhi Thoompu of Cholas period- Animal Husbandry, Wells designed for cattle use. Agriculture and Agro processing, - Knowledge about Sea – Fisheries, Pearl, Conche diving.

தமிழ் கணினி: அறிவியல் தமிழ் வளர்ச்சி - தமிழ் கணினி, தமிழ்

புத்தகங்களின் டிஜிட்டல் மயமாக்கல், தமிழ் டிஜிட்டல் நூலகம், தமிழ் மென்பொருள் உருவாக்கம் - தமிழ் மெய்நிகர் அகாடமி - சொற்குவை திட்டம்.

TAMIL COMPUTING: Development of Scientific Tamil – Tamil Computing, Digitization of Tamil books, Tamil Digital Library, Development of Tamil Software – Tamil virtual Academy – Sorkuvai project.

தமிழின் எதிர்காலமும் தகவல் தொழில்நுட்பமும்- உலகமயமாக்கலும் தகவல் தொழில் நுட்பமும் - கணினிக்கு தமிழ் கற்று கொடுத்தல் - தமிழ் மொழித் தொழில் நுட்பத்தில் வளங்கள்.

Future of Tamil and Information Technology- Globalization and Information Technology-Teaching Tamil for Computer-Resources in Tamil Language Technology.

மொத்தம்: 15 காலங்கள்

பா.வெ. எண்	பாடத்திட்டத்தின் வெளிப்பாடு
CO1	அறிவியலில் தமிழ் மொழியின் பயன்பாடு பற்றி தெரிந்து கொள்வார்கள்
CO2	பல்வேறு தொழில்நுட்பத்தில் தமிழ் மொழியின் தாக்கம் பற்றி அறிந்து கொள்வார்கள்

பாட நூல்கள்:

1. **டாக்டர், வா.செ .குழந்தைசாமி (1985),** " அறிவியல் தமிழ் " , பாரதி பதிப்பகம், 126/108, உஸ்மான் சாலை, தியாகராய நகர் , சென்னை 600017.
2. **சுப. திண்ணப்பன், (1995),** "கணினியும் தமிழ் கற்பித்தலும்", புலமை வெளியீடு, 38-B மண்ணத்நதோட்டத் தெரு, ஆழ்வார்பேட், சென்னை 600018.
3. **மு. பொன்னவைக்கோ, (2003),** "வளர் தமிழில் அறிவியல் – இணையத்தமிழ்", அனைத்திந்திய அறிவியல் தமிழ்க்கழகம், தஞ்சாவூர் 615005
4. **துரை. மணிகண்டன், (2008),** "இணையமும் தமிழும்", நல் நிலம் பதிப்பகம், 7-3, சிமேட்லி சாலை, தியாகராய நகர், சென்னை 600017.

MA22251 **APPLIED MATHEMATICS - II**
(Common to all Branches except MR)

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. Acquire the concepts of vector calculus needed for problems in all engineering disciplines and compute different types of integrals using Green's, Stokes' and Divergence theorems.
2. Skilled at the techniques of solving ordinary differential equations that model engineering problems.
3. Extend their ability of using Laplace transforms to create a new domain in which it is easier to handle the problem that is being investigated.
4. Explain geometry of a complex plane and state properties of analytic functions.
5. Understand the standard techniques of complex variable theory so as to apply them with confidence in application areas such as heat conduction, elasticity, fluid dynamics and flow of electric current.

UNIT I VECTOR CALCULUS 12

Gradient, divergence and curl - Directional derivative - Vector identities – Irrotational and solenoidal vector fields - Line integral over a plane curve – Surface integral - Area of a curved surface - Volume integral - Green's theorem in a plane, Gauss divergence theorem and Stokes' theorem (excluding proofs) – Verification and application in evaluating line, surface and volume integrals.

UNIT II ORDINARY DIFFERENTIAL EQUATIONS AND ITS APPLICATIONS 12

Differential equations of first order – Equations of the first order and first degree – Linear equations – Higher order linear differential equations with constant coefficients - Method of variation of parameters - Cauchy's and Legendre's linear equations - Simultaneous first order linear equations with constant coefficients – Applications of Linear differential equations – Oscillatory electrical circuit – Deflection of beams.

UNIT III LAPLACE TRANSFORM 12

Conditions for existence - Transform of elementary functions - Transforms of unit step function and impulse functions – Basic properties – Shifting theorems - Transforms of derivatives and integrals of functions - Derivatives and integrals of transforms - Initial and final value theorems - Transform of periodic functions. Inverse Laplace transforms - Convolution theorem – Application to solution of linear ODE of second order with constant coefficients using Laplace transformation techniques.

UNIT IV ANALYTIC FUNCTIONS 12

Analytic functions - Necessary and sufficient conditions (Cauchy-Riemann equations) - Properties of analytic function - Harmonic conjugates - Construction of analytic functions - Conformal mapping – Mapping by functions W = Z + C, CZ, 1/Z, Z2 – Joukowski's transformation- Bilinear transformation.

UNIT V COMPLEX INTEGRATION 12

Cauchy's integral theorem - Cauchy's integral formula - Taylor's and Laurent's series expansions - Singular points - Residues - Cauchy's Residue theorem – Application of residue theorem for evaluation of real integrals – Use of circular contour and semi-circular contour.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Interpret the fundamentals of vector calculus and execute evaluation of line, surface and volume integrals using Gauss, Stokes and Green's theorems.	**3**
CO2	Solve first order linear, homogeneous differential equations and use series solution method to solve second order differential equations.	**3**
CO3	Determine the methods to solve differential equations using Laplace transforms and Inverse Laplace transforms.	**3**
CO4	Explain Analytic functions and Categorize transformations.	**3**
CO5	Perform Complex integration to evaluate real definite integrals using Cauchy integral theorem and Cauchy's residue theorem	**3**

TEXTBOOKS:

1. Erwin Kreyszing, Herbert Kreyszing, Edward Norminton, "Advanced Engineering Mathematics", 10th Edition, John Wiley, 2015.
2. Grewal .B.S, Grewal .J.S "Higher Engineering Mathematics",43rd Edition, Khanna Publications, Delhi, 2015.

REFERENCES:

1. Dass, H.K., and Rajnish Verma, "Higher Engineering Mathematics", S. Chand Private Ltd., 2011.
2. Ramana B.V, "Higher Engineering Mathematics", Tata McGraw Hill Publishing Company, New Delhi, 2013.
3. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", 9th Edition, Laxmi Publication (p) Ltd., 2014.

E-RESOURCES:

1. https://nptel.ac.in/courses/111/105/111105134/
2. https://nptel.ac.in/courses/111/105/111105121/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3										3		
2	3	3	2									3		
3	3	3	2									3		
4	3	3										3		
5	3	3										3		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

PH22253 **ENGINEERING MATERIALS**
(Common to AE, ME, MN)

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To impart the knowledge about the properties of engineering and ceramic materials to the students.
2. To enhance the knowledge about the electron behaviour in the semiconductor and dielectric materials.

UNIT I PHASE DIAGRAMS AND NON-FERRROUS ALLOYS 8

Solid solutions - Hume Rothery's rules – Phase rule - single component system - one- component system of Iron - binary phase diagrams - Isomorphous systems - Tie-line rule - the Lever rule - application to Isomorphous system - Cu – Ni system - Eutectic phase diagram - Peritectic phase diagram - other invariant reactions - Cu – Zn system - Microstructural change during cooling.

UNIT II FERROUS ALLOYS AND HEAT TREATMENT 10

Fe-C equilibrium diagram : phases, invariant reactions - microstructure of slowly cooled steels - Eutectoid steel, hypo and hypereutectoid steels - effect of alloying elements on the Fe-C system - Diffusion in solids: Fick's laws - phase transformations - T-T-T-diagram for eutectoid steel - Pearlite, Baintic and Martensitic transformations - tempering of Martensitic - Heat treatment of steels : Annealing - Normalizing - Quenching and Tempering - Case hardening - Induction, Flame and Laser hardening - Carburizing, Cyaniding, Carbonitriding and Nitriding.

UNIT III SEMICONDUCTING MATERIALS 8

Introduction - classification of materials based on band theory (metals, semiconductors and insulators) - intrinsic and extrinsic semiconductors - carrier concentration in intrinsic semiconductor (derivation) - effect of temperature on Fermi level - compound semiconductors - variation of electrical conductivity in intrinsic semiconductors with temperature - Band gap determination of intrinsic semiconductor (derivation and experiment) - Hall effect (derivation and experiment).

UNIT IV DIELECTRIC, MAGNETIC AND SUPERCONDUCTING MATERIALS 10

Dielectric materials - Dielectric constant - Polarization of dielectric materials - Types of Polarization (Polarisability) - Equation of internal fields in solid (One- Dimensional) (Derivation) - Claussius-Mosotti Relation for elemental dielectric materials - Dielectric Breakdown - Frequency dependence of dielectric constant, Dielectric Losses - Important applications of dielectric material.

Magnetic Materials: Dia, Para and Ferro magnetic material - Domain theory for Ferro magnetic materials - Phenomena of Hysteresis and its applications - Ferrites and its structures.

Introduction to Superconductivity : Meissner effect - Properties of superconductors - Type I and Type II superconductors - BCS theory (Qualitative) - Low Tc and High Tc (alloy) superconductors - Ceramic superconductors (oxide superconductors) - Applications of Superconductors.

UNIT V CERAMIC AND NEW MATERIALS 9

Ceramics : types and applications, **Composites:** Ceramic Fibres - Fibre reinforced Plastics - Fibre reinforced Metal - **Metallic glasses**: preparation, Properties and applications.

Shape memory alloys : shape memory effect, phases, pseudo elastic effect, NiTi alloy, Properties and applications.

Nanomaterials: preparation, properties and applications.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Know about the phase diagrams of various alloys	**3**
CO2	Know about the heat treatment of alloys and alloy steels.	**3**
CO3	Understand the behavior of electrons in the semiconductors.	**3**
CO4	Know about the properties and engineering applications of magnetic and dielectric materials.	**3**
CO5	Enhance knowledge about ceramics and smart materials.	**2**

TEXTBOOKS:

1. Arumugam. M, "Materials Science", Anuradha Publications, 2015.
2. Rajendran. V, "Engineering Physics", Tata McGraw Hill, 2015.
3. Suresh. R and Jayakumar. V, "Materials Science", Lakshmi Publications, 2003.
4. Raghavan. V, "Materials Science and Engineering - A first course", Sixth Edition, PHI publications, 2015.

REFERENCES:

1. Gaur. R.K and Gupta. S.L, "Engineering Physics", Dhanpat Publications, 2015.
2. Avadhnaulu. M.N and Kshirsagar, "A Text book of Engineering Physics", S. Chand & Co. 2006.
3. Kittlel. C, "Introduction to Solid State Physics", 7th Edition, Wiley Eastern Ltd., 2004.
4. Azaroff. L.V and Brophy. J.J, "Electronic Processes in Materials", McGraw Hill., 1963.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2							1		2		
2	3	2	2	2	2	2			2	1		2		
3	3					2				1		2		
4	3		2			2				1		2		
5	3	2	2	2	2	2			2	1		2		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22201 **ENGINEERING MECHANICS**
(Common to ME, MN, MR)

L	T	P	C
2	1	0	3

COURSE OBJECTIVES:

1. To understand the concept of equilibrium of particles.
2. To understand the concept of equilibrium of rigid bodies.
3. To understand the concept of first and second moment of area.
4. To understand the concept of various types of frictions and applications.
5. To understand the principle of work energy method, Newton's law and impact of elastic bodies.

UNIT I BASICS AND STATICS OF PARTICLES 9

Introduction - Units and Dimensions - Laws of Mechanics - Principle of transmissibility - Parallelogram and triangular Law of forces - Vectorial representation of forces - Vector operations of forces - additions, subtraction, dot product, cross product - Coplanar Forces - rectangular components - Equilibrium of a particle - Lami's theorem - Forces in space - Equilibrium of a particle in space - Equivalent systems of forces.

UNIT II STATICS OF RIGID BODIES AND ANALYSIS OF STRUCTURES 9

STATICS OF RIGID BODIES: External, Internal forces - moment of a force - Varignon's theorem - moment of a couple - resolution of a force into a force and a couple - reduction of a system of forces - reactions at supports and connections - equilibrium of a two and three force bodies - case studies.

ANALYSIS OF STRUCTURES: Simple trusses - Method of joints, method of sections - joints under special loading conditions - space trusses - analysis of frames.

UNIT III CENTROID, CENTRE OF GRAVITY AND MOMENT OF INERTIA 9

Centroid of areas, composite areas, Centre of Gravity- Theorems of Pappus and Guldinus- Parallel axis theorem and perpendicular axis theorem - determination of moment of inertia of plane figures, polar moment of inertia-radius of gyration - mass moment of inertia of simple solids.

UNIT IV FRICTION 9

Laws of dry friction - angles of friction-coefficient of static and kinetic friction - wedges - surface contact friction - belt friction - journal bearings - axle friction - thrust bearings - disc friction - Point contact friction - wheel friction - rolling resistance - case studies.

UNIT V DYNAMICS OF PARTICLES 9

KINEMATICS: Introduction-plane, rectilinear and rotary motion-time dependent motion -rectangular coordinates - projectile motion.

KINETICS: Newton's II law - D'Alembert's principle - Energy - potential energy - kinetic energy - conservation of energy - work done by a force - work energy method.

IMPULSE AND MOMENTUM: Concept of conservation of momentum - Impulse-Momentum principle - Impact - Direct central impact, oblique central impact, impact of a moving train on the springboard.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Understand and analyze the various methods to determine the resultant forces and its equilibrium acting on a particle in 2D and 3D.	2
CO2	Understand and analyze the concept of reaction forces and moment of various support systems with rigid bodies in 2D and 3D in equilibrium.	2
CO3	Evaluate centroid, Area moment of Inertia and Mass moment of Inertia of cross section of any structural member.	3
CO4	Correlate the engineering problems dealing with force, displacement, velocity and acceleration equations	3
CO5	Evaluate the problems in friction and rigid body dynamics	3

TEXTBOOKS:

1. Beer Ferdinand P, Russel Johnston Jr., David F Mazurek, Philip J Cornwell, Sanjeev Sanghi, Vector Mechanics for Engineers: Statics and Dynamics, McGraw Higher Education., 11th Edition, 2017.
2. Vela Murali, "Engineering Mechanics-Statics and Dynamics", Oxford University Press, 2018.
3. Rajasekaran S and Sankarasubramanian G, "Engineering Mechanics Statics and Dynamics", 3rd Edition, Vikas Publishing House Pvt. Ltd., 2005.

REFERENCES:

1. Boresi P and Schmidt J, Engineering Mechanics: Statics and Dynamics, 1/e, Cengage learning, 2008.
2. Hibbeller, R.C., Engineering Mechanics: Statics, and Engineering Mechanics: Dynamics, 13th Edition, Prentice Hall, 2013.
3. Irving H. Shames, Krishna Mohana Rao G, Engineering Mechanics – Statics and Dynamics, 4th Edition, Pearson Education Asia Pvt. Ltd., 2005.
4. Meriam J L and Kraige L G, Engineering Mechanics: Statics and Engineering Mechanics: Dynamics, 7th Edition, Wiley student edition, 2013.
5. Timoshenko S, Young D H, Rao J V and Sukumar Pati, Engineering Mechanics, 5th Edition, McGraw Hill Higher Education, 2013.

E-RESOURCES:

1. https://nptel.ac.in/courses/112103108

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	2	1	2								2	
2	3	2	2	1	2								2	
3	3	2	3	1	3								2	
4	3	2	3	1	3								2	
5	3	2	3	1	3								2	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

L	T	P	C
3	0	0	3

EE22151 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING
(Common to all Branches except CH, EE, EC)

COURSE OBJECTIVES:

1. To understand the basic theorems used in Electrical circuits.
2. To educate on the different concepts and functions of electrical machines.
3. To introduce electron devices and its applications.
4. To explain the principles of digital electronics.
5. To impart knowledge on the principles of measuring instruments.

UNIT I ELECTRICAL CIRCUITS 9

Ohm's Law – Kirchhoff's Laws - Steady State Solution of DC Circuits using Mesh and Nodal Analysis -Introduction to AC Circuits - Waveforms and RMS Value - Power and Power factor - Single Phase and Three Phase AC Balanced Circuits.

UNIT II ELECTRICAL MACHINES 9

Construction, Principle of Operation, Basic Equations and Applications of DC Generators, DC Motors, Single phase induction Motor, Single Phase Transformer.

UNIT III SEMICONDUCTOR DEVICES AND APPLICATIONS 9

Characteristics of PN Junction Diode - Zener Effect - Zener Diode - LED, Photo diode and its Characteristics-Half Wave and Full Wave Rectifiers-Voltage Regulation. Bipolar Junction Transistor- Common Emitter Configuration, Characteristics and CE as an Amplifier - Photo transistors.

UNIT IV DIGITAL ELECTRONICS 9

Number System Conversion Methods–Simplification of Boolean Expression using K-Map – Half and Full Adders – Flip-Flops – Shift Registers - SISO, SIPO, PISO, PIPO and 4-bit Synchronous and Asynchronous UP Counters.

UNIT V MEASURING INSTRUMENTS 9

Types of Signals: Analog and Digital Signals- Construction and working Principle of Moving Coil and Moving Iron Instruments (Ammeters and Voltmeters), Dynamometer type Watt meters and Energy meters. Instrumentation Amplifier, – R-2R ladder Type D/A Converter - Flash Type and Successive Approximation Type A/D Converter.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Compute the electric circuit parameters for simple problems	4
CO2	Understand the construction and characteristics of different electrical machines	4
CO3	Describe the fundamental behavior of different semiconductor devices and circuits.	4
CO4	Design basic digital circuits using Logic Gates and Flip-Flops	4
CO5	Analyze the operating principle and working of measuring instruments	4

TEXTBOOKS:

1. Kothari DP and I.J Nagrath, “Basic Electrical and Electronics Engineering”, 2nd Edition, McGraw Hill Education, 2020.
2. SedhaR.S., "A Text Book of Applied Electronics", S. Chand & Co., 2014

REFERENCES:

1. Muthusubramanian R, Salivahanan S and Muraleedharan K A, "Basic Electrical, Electronics Engineering", Tata McGraw Hill, 2013.
2. MehtaVK,"Principles of Electronics", S. Chand &Company Ltd, 2010.
3. M. Morris Mano, "Digital Logic & Computer Engineering", Prentice Hall of India, 2004.
4. Mahmood Nahvi and Joseph A.Edminister,"Electric Circuits", Schaum' Outline Series, McGraw Hill, 4th Edition, 2007.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	3	3			2					2		
2	3	3	3	3			2					2		
3	3	3	3	3			2					2		
4	3	3	3	3			2					2		
5	3	3	3	3			2					2		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22211 **PRODUCTION DRAWING LABORATORY**
(Common to ME and MN)

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

1. To introduce the concept of 2D drafting using CAD packages.
2. To improve communications through documentation, and to promote awareness for manufacturing.
3. To introduce students to understand standards of drawing in mechanical engineering
4. To acquire knowledge in Coordinate Measuring machine (CMM) for geometric features

LIST OF EXPERIMENTS

INTRODUCTION TO COMPUTER AIDED DRAFTING

1. Introduction to Computer Aided Drafting hardware – Overview of application software – 2D drafting commands like Layers, Block, Insert (Auto CAD) for simple objects – Dimensioning.

EXPERIENTIAL LEARNING ON LIMITS, FITS AND TOLERANCE THROUGH MACHINE ELEMENTS

2. Basics of Limits, fits, and Tolerance – Identification of types of fits by simple assembly of machine components – Selection of fits from standard tables – types of fits – Demonstration

GEOMETRIC DIMENSIONING

3. Basics of Geometric Dimensioning and Tolerance – Measuring of Machine components using CMM – Experiment on cylindricity, circularity, parallelism and perpendicularity.

PRACTICE ON ASSEMBLY DRAWINGS

4. Cotter joint, knuckle joint, flange coupling, universal coupling, footstep bearing, Plummer block, connecting rod ends, screw jack (any four)

NOTE:

1. Exposer to CMM for the measurement of Geometric dimensioning is Mandatory
2. Any two-assembly drawing should be practiced manually by the student.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	The students will be able to read and interpret the production drawings	3
CO2	The students will be able to understand proper fits and tolerances.	5
CO3	The students will generate assembly drawings for various mechanical products	5
CO4	The students will acquire skill to measure the machine components geometry using CMM	4

REFERENCES:

1. Gopalakrishna K.R., “Machine Drawing”, Subhas Publishers, Bangalore, 2013.
2. Gill P.S, ”Machine Drawing”, S.K. Kataria & Sons Publications, 2013
3. Bhatt.N.D, “Machine Drawing”, Chorotar Publishing House, 2011.

4. Sham Tickoo, "AutoCAD 2017: A Problem-Solving Approach, Basic and Intermediate", 23rd Edition, 2017
5. James D. Bethune Boston University, "Engineering Graphics with AutoCAD 2002", Pearson Education, 2005.
6. Alan Kalameja, "AutoCAD 2008: A tutor for Engineering Graphics", Auto Desk Press 2007

E-RESOURCES:

1. https://thesourcecad.com/autocad-tutorials/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3				3					2		3	2	
2	3				3					2		3	2	
3	3		1		3					2		3	2	
4	3				3				1			3	2	
5	3				3					2		3	2	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
	HARDWARE	
1.	Computer Server	1
2.	Computer systems networked to the server	30
3.	A3 size plotter	1
4.	Laser Printer	1
	SOFTWARE	
5.	Licensed software for Drafting and Modeling & operating system	30

EE22111 **BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY**

L	T	P	C
0	0	2	1

COURSE OBJECTIVES:

1. To provide exposure to the students with hands on experience in basic of Electrical and Electronics wiring connection and measurements.
2. To introduce the students to Electrical Machines and basic laws of Electrical Circuits.

LIST OF EXPERIMENTS

1. Wiring – Residential house wiring and Staircase wiring.
2. (a) AC Analysis- Measurement of electrical quantities–voltage, current, power, and power factor using RLC.
   (b) Study of three phase system.
3. Energy conservation - Measurement and comparison of energy for incandescent lamp and LED lamp.
4. (a) Identification of circuit components (Resistor, Capacitor, Diode and BJT) and soldering practice.
   (b) Signal Measurement- Measurement of peak to peak, RMS, average, period, frequency of signals using CRO.
5. (a) VI Characteristics of Solar photovoltaic panel.
   (b) Design of Solar PV Array and Battery sizing for Residential solar PV system.
6. Design a 5V/12V Regulated Power Supply using FWR and IC7805 / IC7812.
7. DC Analysis- Verification of Ohm's Law and Kirchhoff's Laws.
8. Study of Transformer and motor characteristics.

TOTAL: 30 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, learners will be able to:		
CO1	Wiring of basic electrical system and measurement of electrical parameters.	4
CO2	Verify the basic laws of Electric circuits and select various Electrical Machines.	4
CO3	Construct electronic circuits and design solar photovoltaic system.	4
CO4	Apply the concept of three-phase system.	4
CO5	Construct a fixed voltage regulated power supply.	4

REFERENCES:

1. Mittle V.N, Arvind Mittal, "Basic Electrical Engineering", Tata Mc Graw Hill (India), Second Edition, 2013.
2. Sedha R.S., "A Textbook of Applied Electronics", S. Chand & Co., 2014.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3	3	3					2			2		
2	3	3	3	3					2			2		
3	3	3	3	3					2			2		
4	3	3	3	3					2			2		
5	3	3	3	3					2			2		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
1.	Verification of Ohms and Kirchhoff's Laws: DC Regulated power supply (0-30)V, Bread Board, Resistors, Multimeter, Connecting wires.	1 set
2.	Load test on DC Shunt Motor: Ammeter MC (0-20A), Voltmeter MC (0-300)V, Rheostat 7.5 Ω, 10 A, Tachometer, Field Rheostat 175 Ω, 1.5 A, Connecting wires.	1 set
3.	Load test on Self Excited DC Generator: DC shunt generator (0-300V), Ammeter (0-30 A), (0-2A), Voltmeter (0-30V), Rheostat 175Ω, 250 Ω, Tachometer, Connecting Wires.	1 set
4.	Load test on Single phase Transformer: Ammeter (0-30) A, (0-5) A, Voltmeter (0-150)V, (0-300)V, Wattmeter – 300V, 5A, UPF, Autotransformer, Single phase, transformer, Connecting wires.	1 set
5.	Load Test on Induction Motor: Ammeter MI (0-20A), Voltmeter MI (0-300)V, Wattmeter – 300V, 30 A, Tachometer – Digital, Single phase Induction motor, Connecting Wires.	1 set
6.	A. Experiment on Transistor based application circuits (Inverting and non-inverting amplifier or switching circuits): Transistor (No-BC107), Resistors- 2.2kΩ, 47KΩ, 10KΩ, 560Ω, Capacitors - 10µF, 3.3µF, 22µF, Bread Board, DC Regulated Power supply (0 - 30 V) Variable, CRO, Connecting wires. B. Experiments on Operational Amplifier based Inverting and non-inverting amplifier: Function Generator 1 KHz, CRO 20 MHz, Dual RPS 0–30V, Op-Amp IC 74, Resistors R1= 100 Ω and RF= 1.5 KΩ, Connecting wires.	1 set
7.	Experiments on ADC: Resistors – 10 KΩ Resistors - 220Ω Capacitor – 150 µF, 10µFADC -0804, Bread Board, Connecting wires, Dual RPS (0–30) V.	1 set
8.	Experiments on 555 timers: IC 555 Timer, Resistor R1, R2 47kΩ, 1kΩ, Resistor R4 220Ω Load, Capacitor, C1 10 µF, Capacitor, C2 0.01 µF, Bread Board, Connecting wires, CRO 20 MHz, 9. 9. RPS (0–30) V.	1 set
9.	DSO: Measurement of Amplitude, Frequency, Time, Phase Measurement using DSO.	1 set

SEMESTER III

MA22355	PARTIAL DIFFERENTIAL EQUATIONS AND NUMERICAL METHODS	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1. Skilled at the techniques of solving partial differential equations.
2. Understand the application of partial differential equations in heat transfer problems.
3. Learn the solution of algebraic, transcendental equations, system of linear equations.
4. Understand the concept of interpolation and approximation.
5. Understand how to solve initial and boundary value problems in differential equations.

UNIT I PARTIAL DIFFERENTIAL EQUATIONS 12

Formation of partial differential equations - Singular integrals - Solutions of standard types of first order partial differential equations - Lagrange's linear equation - Linear homogeneous partial differential equations of second and higher order with constant coefficients.

UNIT II APPLICATIONS OF PARTIAL DIFFERENTIAL EQUATIONS 12

Classification of partial differential equations – Fourier series – Half range Fourier sine and cosine series - Solutions of one-dimensional wave equation – One dimensional equation of heat conduction – Steady state solution of two dimensional equation of heat conduction in Cartesian form (excluding insulated edges) – Steady state solution two dimensional heat equation in polar form (circular, semicircular and quadrant plate).

UNIT III SOLUTION OF EQUATIONS AND EIGENVALUE PROBLEMS 12

Solution of algebraic and transcendental equations: Newton Raphson method - Solution of linear system of equations - Gauss elimination method – Pivoting - Gauss Jordan method – Gauss Seidel Iterative methods - Matrix Inversion by Gauss Jordan method - Eigen values of a matrix by Power method.

UNIT IV INTERPOLATION AND APPROXIMATION 12

Interpolation with unequal intervals - Lagrange's interpolation – Method-Newton's divided difference interpolation – Finite difference operators and its relations - Interpolation with equal intervals - Newton's forward and backward difference formulae.

UNIT V INITIAL AND BOUNDARY VALUE PROBLEMS IN DIFFERENTIAL EQUATIONS 12

Finite difference solution of ordinary differential equations - Finite difference techniques for the solution of two-dimensional Laplace's and Poisson's equations on rectangular domain – One dimensional heat flow equation by explicit and implicit (Crank Nicholson) methods – One dimensional wave equation by explicit method.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Express** proficiency in handling higher order partial differential equations	3
CO2	**Develop** skills in classification, formulation, solution, and interpretation of partial differential equations model	4
CO3	**Have** the fundamental knowledge of solving an algebraic or transcendental	3

	equation, linear system of equations	
CO4	**Appreciate** the numerical techniques of interpolation in various intervals	3
CO5	**Solve** boundary value problems using finite difference method	3

TEXTBOOKS:

1. Grewal .B.S, Grewal .J.S "Higher Engineering Mathematics", 43rd Edition, Khanna Publications, New Delhi, 2015.
2. Kandasamy. P, Thilagavathy. K and Gunavathy. K., "Engineering Mathematics Volume III", 4th Edition, S. Chand & Company Ltd, New Delhi, 2008.
3. Grewal. B.S. and Grewal. J.S., Numerical methods in Engineering and Science, Khanna Publishers, 11th Edition, New Delhi, 2017.

REFERENCES:

1. Erwin Kreyszing, Herbert Kreyszing, Edward Norminton, "Advanced Engineering Mathematics", 10th Edition, John Wiley, 2015.
2. Bali N. P and Manish Goyal, "A Text book of Engineering Mathematics", 9th Edition, Laxmi Publications (P) Ltd., 2014.
3. Sankara Rao. K., Numerical methods for Scientists and Engineers, Prentice Hall of India Private, 3rd Edition, New Delhi, 2007.
4. Venkataraman. M.K. Numerical Methods in Science and Engineering, National Publishers, 2001.

E-RESOURCES:

1. https://nptel.ac.in/courses/111107111
2. https://nptel.ac.in/courses/111/107/111107105/
3. https://nptel.ac.in/courses/111/107/111107063/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	2	2								1	2	
2	3	3	2	2								1	2	
3	3	3	2	2								1	2	
4	3	3	2	2								1	2	
5	3	3	2	2								1	2	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

MN22301 INTRODUCTION TO INDUSTRIAL AUTOMATION

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To emphasize the need and role of automation in industries
2. To impart knowledge on different types of devices used in automation
3. To gain awareness on the concepts and applications of automation

UNIT I ELEMENTS OF AUTOMATION 10

Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Automation in Production System, Production Economics, Costs in Manufacturing, Break Even Analysis, Unit cost of production, Cost of Manufacturing Lead time and Work-in-process.

UNIT II SENSORS AND TRANSDUCERS 9

Sensors – Classification, Static and Dynamic characteristics, Types – Proximity, Inductive, Capacitive, Optical, Displacement, Temperature, Infrared, Ultrasonic, RFID. Optical encoder & Magneto strictive sensor. Potentiometer, Vibrometer and accelerometer.

Transducers – LVDT, Strain Gauge, Piezoelectric, Diaphragm, Capsule and Bellows Pressure transducers

UNIT III MICROCONTROLLER AND EMBEDDED SYSTEM 9

Introduction to Microprocessors and Microcontrollers. Architecture of 8085, 8051 and PIC Micro Controllers. Addressing modes, Instruction set Timing diagram. Applications in automation systems.

UNIT IV LEVELS OF AUTOMATION AND MATERIAL HANDLING TECHNIQUES 9

Levels of Automations, Automated Flow lines, Methods of Work part Transport, Transfer Mechanism, Buffer Storage, Control Functions, and Automation for Machining Operations.

Material handling systems – Conveyors, Automated Guided Vehicle, Automatic tool and pallet changer, Overhead Hoist,

UNIT V APPLICATION AND INTEGRATION 8

Design and Fabrication Considerations. Automated Flow Lines - Concepts, Partial Automation, and Simulation.

Interfacing Handling and Storage with Manufacturing. Product identification system: Barcode, RFID and QR code.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, the students will be able to:		
CO1	**Appraise** the role of various elements available in automation process	3
CO2	**Describe** the working of sensors and transducers used in automation	3
CO3	**Explain** the architecture of various microcontrollers and embedded systems used in automation	3
CO4	**Categorize** the different levels of automation and material handling systems	3
CO5	**Describe** the integration of various elements of automation in real time applications	3

TEXTBOOKS:

1. Ankaj Gupta, "Fundamentals of Microprocessors and Embedded Systems"S.K. Kataria& Sons, 2013.
2. Mikell P.Groover, "Automation, Production Systems, and Computer-integrated Manufacturing" Fourth edition, Pearson, 2016.

REFERENCES:

1. Beno Benhabib, "Manufacturing: Design, Production, Automation, and Integration", CRC Press, First edition, 2003.
2. R. Thomas Wright, "Manufacturing and Automation Technology", Goodheart-Wilcox Publisher, 2004.
3. Roger W Bolz, "Manufacturing Automation Management: A Productivity Handbook", Springer Publications, 2011
4. B.K. Ghosh, Ning Xi and T.J.Tarn, "Control in Robotics and Automation: Sensor Based Integration, Academic Press Inc. 2000.

E-RESOURCES:

1. https://nptel.ac.in/courses/108108147
2. https://nptel.ac.in/courses/106105193
3. https://nptel.ac.in/courses/108105088

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2										1	1	2
2	3	1										1	1	2
3	3	1	1									1	1	2
4	3	2	1	1								1	1	2
5	3	3	3	2	1							1	1	3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22302 **MECHANICS OF MATERIALS**
(Common to ME and MN)

L	T	P	C
2	1	0	3

COURSE OBJECTIVES:

1. To understand the relationship between the forces, internal stresses and the deformations induced in the non-rigid bodies.
2. To familiarize the student in calculating shear force, bending moment, deflection, and slopes in various types of beams for different loading conditions.
3. To solve industrial problems related to springs and shafts.
4. To understand the concepts of thin cylinder and applications related to biaxial stresses.

UNIT I STRESS AND STRAIN **9**

Definition of stress and strain, tension, compression, shear stress and strain – Stress and strain relationship, Hooke's law, Poisson's ratio, Elastic constants and their relations, thermal stresses. Composite bars for static load condition.

UNIT II MEMBERS SUBJECTED TO FLEXURAL LOADS **9**

Types - Transverse Loading in Beams - Shear Force and Bending Moment in Beams – Cantilevers - Simply Supported and Overhanging Beams - Point of contraflexure. Stresses in Beams: Theory of Simple Bending – Analysis of Stress due to bending - Load carrying capacity of Beams.

UNIT III DEFLECTION OF BEAMS AND COLUMNS **9**

Governing differential equation – Double Integration Method - Macaulay's method – Computation of slopes and deflections in beams.

Columns: End Condition – Equivalent Length of Column – Euler's Equation – Slenderness Ratio – Rankine's Formula for Columns.

UNIT IV TORSION OF SHAFTS AND SPRINGS **9**

Torsion - formulation of stresses, deformation in circular and hollow shafts, Stepped shafts. Deflection in shafts for different end conditions - Stresses in helical springs - Deflection of helical springs subjected to tension, and leaf springs.

UNIT V ANALYSIS OF STATE OF STRESS **9**

Biaxial State of Stress – Thin Cylinders– Deformation in Thin Cylinders. Biaxial Stresses: Stresses at a Point on Inclined Planes – Principal Planes and Stresses – Mohr's Circle for Biaxial Stress- Maximum Shear Stress.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Predict** the behavior of the materials for different loading and support conditions	3
CO2	**Select** suitable cross sections for the beams under different loading conditions	4
CO3	**Identify** the methodology to find the deflections occurred in beams under different loading conditions	3
CO4	**Select** suitable dimensional parameters for the shafts under torsional loads and springs based on calculated stresses, deflection under different conditions	4
CO5	**Calculate** safe dimension for a Pressure vessel based on the parameters and conditions	4

TEXTBOOKS:

1. Bansal, R.K., "A Textbook of Strength of Materials", Laxmi Publications (P) Ltd., 2018.
2. Jindal U.C., "Strength of Materials", Asian Books Pvt. Ltd., New Delhi, 2009.

REFERENCES:

1. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, Low Price Edition, 2017.
2. Ferdinand P. Beer, Russell Johnson, J.r. and John J. Dewole "Mechanics of Materials", McGraw Hill Education,8th Edition, 2019.
3. Rattan, "Strength of Materials", McGraw Hill Education, 3rd Edition, 2017.
4. Egor. P.Popov "Engineering Mechanics of Solids" Pearson, 2010.

E-RESOURCES:

1. https://nptel.ac.in/courses/112107146
2. https://nptel.ac.in/courses/112106141
3. https://archive.nptel.ac.in/courses/105/105/105105108/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	3		1	1								3	
2	3	3		2	2								3	
3	3	3											3	
4	3	3		2									3	
5	3	3											3	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22304 **THEORY OF MACHINES**

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. To understand formation of mechanisms and their kinematics.
2. To understand the fundamentals of gears and gear trains.
3. To analyze the forces acting on simple mechanical systems.
4. To perform balancing of masses.
5. To understand the fundamentals of vibrations.

UNIT I KINEMATICS OF MECHANISMS 14

Mechanisms – Kinematics concepts and definitions – Degree of freedom – Kutzbach criterion, Gruebler‟s criterion – Grashof‟s Law, Kinematic inversions of Four-bar chain and Slider crank chains – Analysis of simple mechanisms - Graphical method using relative velocity.

UNIT II GEARS AND GEAR TRAINS 12

Spur gear - Law of toothed gearing - Involute gearing - Interchangeability - Gear tooth action interference and undercutting. Gear trains - Epicyclic gear trains and their applications– Introduction to parallel axis gears trains and differential gear trains.

UNIT III DYNAMIC FORCE ANALYSIS 12

Dynamic force analysis – Inertia force and Inertia torque– D'Alembert's principle – Dynamic force analysis in I.C. Engines. Flywheel- Applications in punching and riveting machines.

UNIT IV BALANCING OF MASSES AND GYROSCOPIC MOTION 10

Balancing of rotating masses under single and several planes–Introduction to balancing of reciprocating masses. Principles of gyroscopic motion- Determination of gyroscopic couple- Ships and Airplane.

UNIT V VIBRATIONS 12

Degrees of freedom – Single degree of freedom, Free vibration –Natural frequency – Damped vibration - Types of Damping–vibration isolation materials – Critical speeds of shaft. Introduction to Forced Vibrations.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Analyze** the kinematics of given mechanism by relative velocity method	4
CO2	**Calculate** the characteristics parameters of various gears and performance of epicyclic gear trains.	3
CO3	**Evaluate** the dynamic forces acting on the elements of slider crank mechanisms.	3
CO4	**Analyze** and solve the unbalancing forces in masses rotating in different planes.	4
CO5	**Calculate** the natural frequency of vibrating bodies under various vibratory motions.	3

TEXTBOOKS:

1. Rattan S.S., "Theory of Machines", Tata McGraw-Hill, New Delhi, 2017.
2. Shigley J.E., Pennock G.R and Uicker J.J., "Theory of Machines and Mechanisms", Oxford University Press, 2015.

REFERENCES:

1. Rao J.S. and Dukkipati, "Mechanism and Machine Theory", Wiley- Eastern Ltd., New Delhi, 2015.
2. John Joseph Uicker, Gordon Pennock, Joseph E. Shigley, "Theory of Machines and Mechanisms", 5th Edition, Oxford University Press, 2017.
3. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2017.
4. Sadhu Singh, "Theory of Machines: Kinematics & Dynamics", Pearson Education India, 3rd Edition, 2016.
5. Ghosh A. and Mallick A.K., "Theory of Mechanisms and Machines", Affiliated East West Pvt. Ltd, New Delhi, 2008.

E-RESOURCES:

1. https://nptel.ac.in/courses/112104121
2. https://nptel.ac.in/courses/112106270
3. https://nptel.ac.in/courses/112104114

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3									3			3	
2	3	2								2			3	
3	3	2								2			3	
4	3									3			3	
5	3	2								2			3	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

ME22305 MANUFACTURING TECHNOLOGY

L	T	P	C
3	0	0	3

COURSE OBJECTIVES:

1. To make the students understand fundamentals and types of casting and welding processes.
2. To impart knowledge on bulk, sheet metal forming and Powder metallurgy.
3. To teach the students about the various operations that can be performed in various machine tools.
4. To make the students to realize the importance of nontraditional machining processes in present manufacturing scenario.
5. To validate the principles studied in theory by performing experiments in the laboratory.

UNIT I METAL CASTING PROCESSES 9

Sand Casting – Green Sand Mould – Type of patterns - Pattern Materials – Pattern allowances – Moulding sand Properties and testing – Cores –Types and applications – Principle of special casting processes- Shell, investment – Pressure die casting – Centrifugal Casting – Continuous casting - Stir casting – Basic defects in Sand casting.

UNIT II METAL JOINING PROCESSES 9

Fusion welding processes – Type of Gas welding – Flame characteristics – Arc welding, Electrodes, Polarities – Shielded Metal arc welding -Gas metal arc welding – Submerged arc welding – Electro slag welding – Gas Tungsten arc welding – Principle and application of special welding processes – Plasma arc welding – Thermit Welding – Friction welding – Friction stir welding - Resistance welding principle – spot and seam welding – Brazing and soldering.

UNIT III METAL FORMING PROCESSES AND POWDER METALLURGY 10

Bulk Deformation Processes- Hot working and cold working of metals – Forging processes –Typical forging operations – Rolling of metals – Types of Rolling – Flat strip rolling – shape rolling operations –Principle of rod and wire drawing – Tube drawing – Principles of Extrusion.

Sheet Metal Deformation Processes - Typical shearing, bending and drawing operations – Stretch forming operations – Metal spinning – Introduction of Explosive forming, magnetic pulse forming, Super plastic forming – Incremental forming.

Powder metallurgy – Principal steps involved advantages, disadvantages and limitations of powder metallurgy.

UNIT IV METAL MACHINING PROCESSES 10

Classification of machining processes and machine tools. Tool's materials, different types of cutting tools, tool geometry and nomenclature of single point cutting tool, tool life MRR, Concept of cutting speed, feed and depth of cut.

General principles (with schematic diagrams only) of working and commonly performed operations in the following machines: Lathe, Shaper, Planer, Horizontal milling machine, drilling machine, Cylindrical grinding machine, Capstan and Turret lathe.

UNIT V NON TRADITIONAL MACHINING PROCESSES 7

General principles and applications of the following processes: Abrasive jet machining, Ultrasonic machining, Electric discharge machining, Electro chemical machining, Plasma arc machining, Electron beam machining and Laser beam machining.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Classify** the different types of casting process and **select** a suitable casting and welding processes for a given material and applications	3
CO2	**Select** a suitable deformation and powder metallurgy processes for a given application	3
CO3	**Analyze** the tool life, MRR during machining and will **develop** a process planning sheet for a given component	3
CO4	**Select** a proper Non-Traditional Machining method for a given component	3
CO5	**Validate** the principles studied in theory by performing experiments in the laboratory.	3

TEXTBOOKS:

1. P. C. Sharma, "A Textbook of Production Technology", S. Chand Publications, 2022.
2. R. K. Rajput, " A Textbook of Manufacturing Technology", Laxmi Publications, 2023.

REFERENCES:

1. Mikell P. Groover, "Fundamentals of Modern Manufacturing: Materials, Processes, and Systems", Wiley Publications, 7th Edition, 2019.
2. Serope Kalpakjian & Steven Schmid, "Manufacturing Engineering & Technology", Pearson education, 2022.
3. J. T. Black, Ronald A. Kohser, "De Garmo's Materials and Processes in Manufacturing", 13th Edition, 2019.

E-RESOURCES:

1. https://archive.nptel.ac.in/courses/112/107/112107219/
2. https://nptel.ac.in/courses/112105127
3. https://archive.nptel.ac.in/courses/112/105/112105126/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	2	1			2							2	
2	3	2	1			2								
3	3	2	1			2							2	
4	3	2	1			2							1	
5	3	2	1			2							1	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

EE22359 **ELECTRICAL DRIVES AND CONTROLS: THEORY AND PRACTICES (Common to ME and MN)**

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. To understand the basic concepts of electrical machines and their performance.
2. To obtain an overview of different dc and ac motors and special electrical machines.
3. To apply various speed control techniques for DC motor drives, AC motor drives
4. To validate the principles studied in theory by performing experiments in the laboratory.

UNIT I INTRODUCTION **12**

Basic Elements – Types of Electric Drives – factors influencing the choice of electrical drives – heating and cooling curves – classes of duty – Preventive maintenance of electrical drive systems- Industrial Hazards and Safety Measures.

UNIT II DRIVE MOTOR CHARACTERISTICS & SPECIAL MACHINES **12**

DC motors: principle, classification, characteristics, merits & demerits, applications–Three phase Induction motors: principle, classification, characteristics, merits & demerits, applications–Principle, classification, construction and characteristics of stepper motor, BLDC motor, Servo motor.

UNIT III CONVENTIONAL AND SOLID STATE SPEED CONTROL OF DC AND AC DRIVES **12**

Speed control of DC series and shunt motors – Armature and field control, Ward Leonard control system - Using controlled rectifiers and DC choppers –Speed control of three phase induction motor– Inverter fed induction motor drive – Slip power recovery scheme.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

1. Load test on DC Shunt & DC Series motor
2. Speed control of DC shunt motor (Armature, Field control)
3. AC to DC half & fully controlled converter.
4. Speed control of DC motor using Power Electronic Drive
5. Characteristics of DC and AC servo motors
6. Load test on three phase squirrel cage Induction motor.
7. Speed control of three phase slip ring Induction Motor
8. Load test on single phase Induction Motor.
9. V/F control of three-phase induction motor using Power Electronic Drive.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Describe** the structure of electric drive systems and their role in various applications.	3
CO2	**Select** DC and AC motor for practical applications based on its characteristics.	3
CO3	**Understand** the operation of converters, choppers, inverters and ac voltage controllers for DC and AC drives.	3
CO4	**Perform** speed characteristics of different electrical machine.	3
CO5	**Analyze** the performance of AC, DC motor using power electronic drive.	3

TEXTBOOKS:

1. Gopal K.Dubey, "Fundamentals of Electrical Drives", Narosa Publishing House, 2001.
2. Vedam Subrahmaniam, "Electric Drives (concepts and applications)", Tata McGraw-Hill, 2017.
3. Nagrath .I.J. & Kothari .D.P, "Electrical Machines", Tata McGraw-Hill, 1998.

REFERENCES:

1. Pillai.S.K, "A first course on Electric drives", Wiley Eastern Limited, 1998.
2. Singh.M.D. K.B.Khanchandani, "Power Electronics", Tata McGraw-Hill, 19983.
3. Partab. H., "Art and Science and Utilisation of Electrical Energy", Dhanpat Rai and Sons, 1994.
4. Philip Kiameh "Electrical Equipment Handbook: Troubleshooting & Maintenance", McGraw-Hill, 2003.

E-RESOURCES

.1. https://archive.nptel.ac.in/courses/108/104/108104140/
2. https://nptel.ac.in/courses/108108077
3. https://nptel.ac.in/courses/108104011

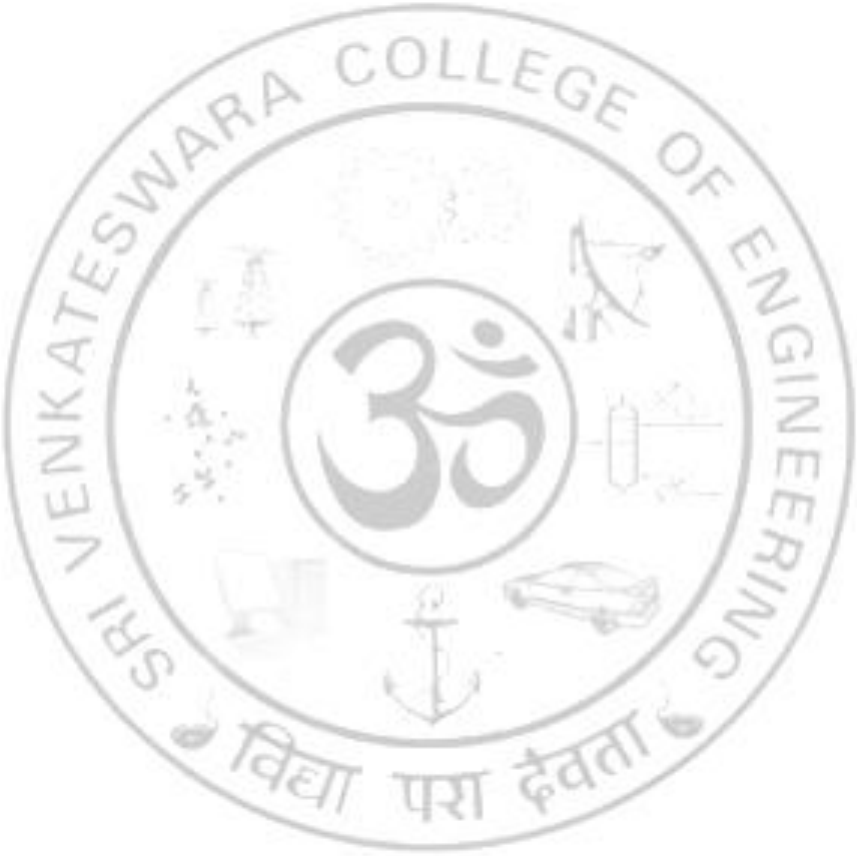
COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	1	1	2		1						2	2	1
2	3	1	1	2								2	2	1
3	3	1	1	2								2	2	1
4	3	1	1	2					2			2	2	1
5	3	1	1	2					2			2	2	1

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS		
SL.No.	**ITEM DESCRIPTION**	**QUANTITY**
1.	DC Shunt Motor with loading arrangement	3
2.	DC Series Motor with loading arrangement	1
3.	Three Phase cage Induction Motor with loading arrangement	4

4.	Three phase slip ring Induction Motor with loading arrangement	2
5.	Single Phase Induction Motor with loading arrangement	2
6.	Single phase SCR based half controlled converter and fully controlled converter along with built-in/separate/firing circuit/module and meter	2
7.	AC drive for speed control of Induction Motor	1



ME22313 MANUFACTURING TECHNOLOGY LABORATORY

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

1. To impart the practical knowledge in casting and joining Processes
2. To impart the basic machining skills in lathe and to equip with the practical knowledge required in the core industries
3. To impart machining skills in gear manufacturing and grinding process.

LIST OF EXPERIMENTS

CASTING

1. Preparation of green sand mould for single piece pattern
2. Preparation of green sand mould for split patterns

WELDING

3. Butt joint using arc welding
4. Lap joint using arc welding
5. Tee joint using arc welding
6. Corner joint using arc welding

LATHE, GRINDING AND SHAPING MACHINE TOOLS

7. Plain turning, Facing, Step turning
8. Grooving, Knurling, Taper turning
9. External thread cutting (Single start)
10. Spur gear cutting using Universal Milling Machine
11. Cylindrical grinding
12. Gear Generation – Hobbing and Shaper

TOTAL : 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Make** a green sand mould using different patterns.	3
CO2	**Select** the suitable welding parameters to make weld joints using arc welding.	3
CO3	**Identify** and **perform** the operations in a lathe machine.	3
CO4	**Perform** gear generation operation in gear shaper.	3
CO5	**Perform** grinding operation on the given cylindrical workpiece to achieve required surface finish.	3

REFERENCES:

1. Serope Kalpak Jian& Steven R. Schmid, "Manufacturing Engineering and Technology", Pearson India Education Services Pvt. Ltd, 7th Edition, 2018.
2. HMT, Production technology, Mc-Graw Hill, 2017.
3. P N Rao, "Manufacturing Technology: Metal Cutting and Machine Tools", Mc-Graw Hill, Volume 2, 4th Edition, 2018.
4. Hajra Choudhury, "Elements of Workshop Technology", Vol. I: Manufacturing Processes., Media Promoters & Publishers Pvt. Ltd, 15th Edition, 2012.

E-RESOURCES:

1. https://archive.nptel.ac.in/courses/112/105/112105219/
2. https://archive.nptel.ac.in/courses/112/107/112107219/
3. https://archive.nptel.ac.in/courses/112/105/112105233/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3								3					
2	3								3					
3	3								3					
4	3								3					
5	3								3					

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
1.	Centre lathes	7
2.	Arc welding machine	5
3.	Gear shaper	1
4.	Cylindrical grinding machine	1
5.	Universal milling machine	1
6.	Arc Welding setup	2
7.	Mould preparation tool sets	2

ME22314 **MATERIAL TESTING LAB**

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

1. To supplement the theoretical knowledge gained in Mechanics of Solids and Material Characterization and Metallurgy subjects.
2. Evaluate the mechanical properties of metallic materials by practical testing
3. Analyze the microstructure of ferrous and non-ferrous materials using metallurgical microscope

LIST OF EXPERIMENTS

1. Tension test on a mild steel rod
2. Double shear test on Mild steel and Aluminum rods.
3. Torsion test on mild steel rod.
4. Impact test on metal specimen (Charpy & Izod)
5. Hardness test on metals – Vickers Micro-hardness, Brinell and Rockwell Hardness Number.
6. Deflection test on beams (Simply supported and Cantilever)
7. Compression test on helical springs
8. Strain Measurement using Rosette strain gauge
9. Comparison of Mechanical properties of steel – using impact & hardness tests
   i. Unhardened specimen ii. Quenched Specimen and iii. Quenched and tempered specimen
10. Microscopic Examination of i. Hardened samples and ii. Hardened and tempered samples

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Determine** the various mechanical properties of steel and non-ferrous materials like hardness, tensile strength and impact strength using Rockwell & Brinell hardness tester, universal testing machine and impact testing machine respectively.	3
CO2	**Evaluate** Young's modulus of steel & aluminum using simply supported and cantilever method	5
CO3	**Evaluate** stiffness and spring index of alloy spring steel using compression test	5
CO4	**Analyze** the microstructure of various heat treated steel, copper alloy and aluminum alloy using optical microscope	4
CO5	**Analyze** the medium carbon steel hardenability using Jomni end quench testing	4

REFERENCES:

1. Strength of materials laboratory manual, Anna University, Chennai - 600 025.
2. Strength of materials laboratory manual, IITM.

E-RESOURCES:

1. VLABS - https://sm-nitk.vlabs.ac.in/

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3							2	3				2	
2	3							2	3				2	
3	3							2	3				2	
4	3				3			2	3	2				
5	3							2	3				2	
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No	ITEM DESCRIPTION	QUANTITY
1.	Universal Tensile Testing machine with double shear attachment (40 Ton Capacity)	1
2.	Torsion Testing Machine (60 Nm Capacity)	1
3.	Impact Testing Machine (300 Nm Capacity)	1
4.	Brinell Hardness Testing Machine	1
5.	Rockwell Hardness Testing Machine	1
6.	Spring Testing Machine for tensile and compressive loads (2500 N)	1
7.	Muffle Furnace (8000°C)	1
8.	Vickers Micro-hardness Tester	1
9.	Deflection (Beam) testing setup – Simply supported & Cantilever	1
10.	Metallurgical Microscopes	2
11.	Metallurgical specimen polishing machine	1
12.	Rosette strain gauge setup	1
13.	Jomni End Quench Test setup	1

SEMESTER IV

GE22451	ENVIRONMENTAL SCIENCES AND SUSTAINABILITY (Common to all Branches)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To introduce the basic concepts of environment, ecosystems and biodiversity and emphasize the biodiversity of India and its conservation.
2. To impart knowledge on the causes, effects and control or prevention measures of environmental pollution.
3. To study and understand the various types of renewable sources of energy and their applications.
4. To familiarize the concept of sustainable development goals, economic and social aspects of sustainability, recognize and analyze climate changes, and environmental management challenges.
5. To inculcate and embrace sustainability practices, develop a broader understanding of green materials and energy cycles, and analyze the role of sustainable urbanization.

UNIT I ENVIRONMENT AND BIODIVERSITY 9

Definition, scope and importance of environment – need for public awareness. Eco-system and Energy flow– food chains, food webs and ecological pyramids, ecological succession. Biodiversity- types-genetic, species and ecosystem diversity– values of biodiversity, India as a mega-diversity nation – hot-spots of biodiversity – threats to biodiversity: fragmentation and habitat loss, poaching of wildlife, human-wildlife conflicts – endangered and endemic species of India –conservation of biodiversity: In-situ and ex-situ.

UNIT II ENVIRONMENTAL POLLUTION 9

Definition, causes, effects and preventive measures of air, water and soil pollution. Marine and thermal pollution - causes, effects and control measures. Light and noise pollution - effect on flora and fauna. Nuclear pollution- Sources, effects and control measures. Disposal of radioactive wastes (Nuclear hazards). Pollution case studies. Role of an individual in the prevention of pollution. Solid, hazardous and E-waste management. Occupational health and safety management system (OHASMS). Environmental protection, Environmental protection acts, categorization of spices according to IUCN.

UNIT III RENEWABLE SOURCES OF ENERGY 9

Energy resources: Growing energy needs, Nonrenewable resources – types, uses. Energy management and conservation - New energy sources, Need of new sources - geo suitability of establishing renewable energy sources, different types new energy sources. Applications of hydrogen energy, ocean energy resources, Tidal energy conversion. Concept, origin and power plants of geothermal energy. Role of an individual in conservation of energy.

UNIT IV SUSTAINABILITY AND MANAGEMENT 9

Development, GDP, Sustainability- concept, needs and challenges-economic, social and aspects of sustainability-from unsustainability to sustainability-millennium development goals, and protocols, Sustainable Development Goals-targets, indicators and intervention areas - Principles of green chemistry, Climate change- Global, Regional and local environmental issues and possible solutions-case studies - Role of non-governmental organization, Concept of carbon credit, carbon footprint - Environmental management in industry-A case study

UNIT V SUSTAINABILITY PRACTICES 9

Zero waste and R concept, circular economy, ISO 18000 series, material life cycle assessment, environmental impact assessment. Wasteland reclamation, Sustainable habitat: green buildings, green materials, energy efficiency and energy audit, sustainable transports. Energy cycles, carbon cycle,

emission and sequestration, Green engineering: sustainable urbanization- socio-economical and technological change. Rainwater harvesting, watershed management, environmental ethics: Issues and possible solutions.

TOTAL : 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Recognize the fundamental role of ecosystems and suggest an appropriate method for the conservation of biodiversity.	3
CO2	Describe the different types of pollution, their effects and strategies to control pollution.	3
CO3	Identify the various renewable energy resources and use the appropriate one thereby conserving non-renewable resources for future generation.	3
CO4	Explain the various goals of sustainable development applicable to suitable technological advancement and societal development.	2
CO5	Summarize the various sustainability practices, green materials, energy cycles, and the role of green engineering in sustainable urbanization.	2

TEXTBOOKS:

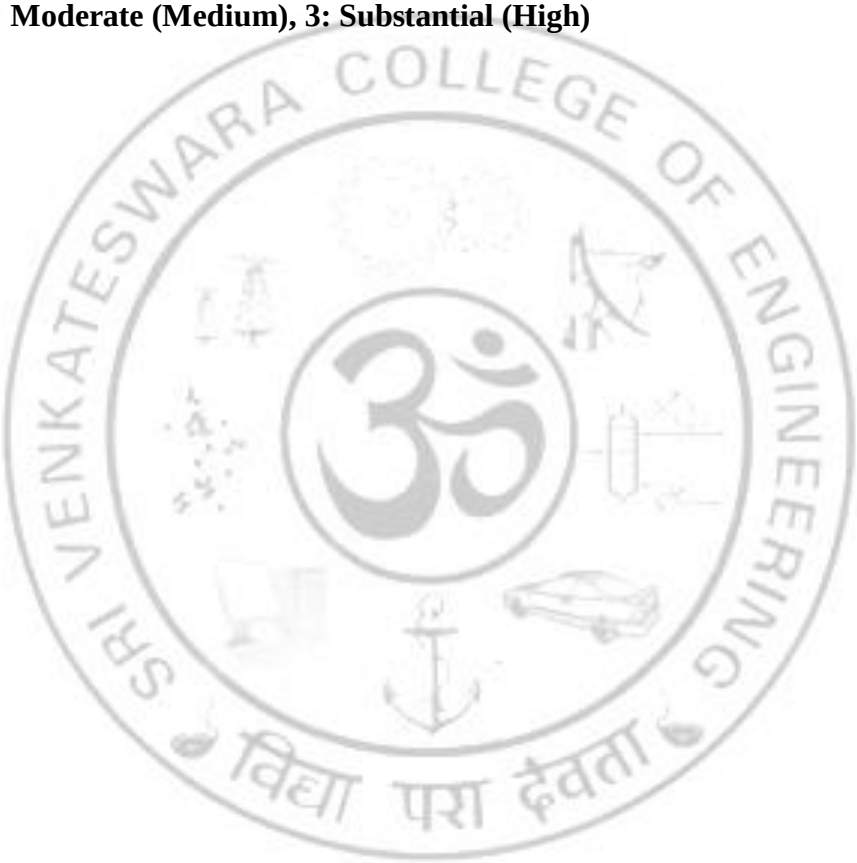
1. Anubha Kaushik and C. P. Kaushik's "Perspectives in Environmental Studies", 7th Edition, New Age International Publishers, 2022.
2. Benny Joseph, 'Environmental Science and Engineering', Tata McGraw-Hill, New Delhi, 2016.
3. Gilbert M. Masters, 'Introduction to Environmental Engineering and Science', 2nd Edition, Pearson Education, 2004.
4. Allen, D. T. and Shonnard, D. R., Sustainability Engineering: Concepts, Design and Case Studies, Pearson. 2011.
5. Bradley. A.S; Adebayo, A.O., Maria, P. Engineering applications in sustainable design and development, CL Engineering, 2015.
6. Environment Impact Assessment Guidelines, Notification of Government of India, 2006.
7. Mackenthun, K.M., Basic Concepts in Environmental Management, Lewis Publication, London, 1998.

REFERENCES:

1. R.K. Trivedi, 'Handbook of Environmental Laws, Rules, Guidelines, Compliances and Standards', Vol. I and II, Enviro Media.
2. Cunningham, W.P. Cooper, T.H. Gorhani, 'Environmental Encyclopedia', Jaico Publ., House, Mumbai, 2001.
3. Dharmendra S. Sengar, 'Environmental law', Prentice Hall of India PVT. LTD, New Delhi, 2007.
4. Rajagopalan, R, 'Environmental Studies-From Crisis to Cure', Oxford University Press, 3rd Edition, 2015.
5. Erach Bharucha "Textbook of Environmental Studies for Undergraduate Courses" Orient Blackswan Pvt. Ltd. 3rd Edition, 2021.

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3					3	3	2		2		1		
2	3					3	3	2		2		2		
3	3		1			3	3	1		2		1		
4	3					3	3	3		2		2		
5	3					3	3	3		2		2		

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)



MN22401 **DESIGN OF MACHINE ELEMENTS**

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. To impart the knowledge on the design for static and fatigue strength of various machine elements.
2. To make the students to understand the design principles of bearings and couplings
3. To familiarize the design and analysis of welded joints and bolted joints.
4. To provide knowledge on the principles and procedures for the design of flexible drive systems.
5. To familiarize the standard procedure for design of cylindrical and non-cylindrical gear pairs.

UNIT I DESIGN FOR STATIC AND FATIGUE STRENGTH 14

Types of design - design process – Types of stresses, Principal stresses, Theories of Failures- problems, Fatigue phenomenon theories. Introduction to Shaft – types of shaft - design of shaft. Standardization, preferred numbers.

UNIT II DESIGN OF BEARINGS AND COUPLINGS 10

Types of bearings – Nomenclature – selection of rolling contact bearings for different industrial applications. Couplings - Types of couplings - Design of rigid flange coupling - Design of flexible coupling.

UNIT III DESIGN OF WELDING JOINT AND FASTENERS 12

Types of welded joints, Nomenclature - Design of welded joint for circumference weld works - eccentrically loaded welded structures. Design of bolted joint for axial and eccentrical loaded conditions. Codes and standards for soldering process.

UNIT IV DESIGN OF FLEXIBLE DRIVES 10

Flexible drive systems - types of flexible drives – design of V- Belt drives, design of chain drives.

UNIT V DESIGN OF GEAR DRIVES 14

Gears - types of gears - nomenclature - classification of gear drives – design of helical gear drives - design of bevel gear drive. Speed reducer - Design of worm gear drive.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, Students will be able to:		
CO1	**Analyze** the stresses induced in simple machine elements and shafts subjected to static and fatigue loading.	4
CO2	**Select** and design the required rolling contact bearing to support the given application.	3
CO3	**Design** the permanent and temporary joints subjected to direct and eccentric loading conditions.	4
CO4	**Apply** procedures to design the transmission elements like belt and chain drives.	3
CO5	**Apply** the design procedure for helical, bevel and worm gear drives to transmit power.	3

TEXTBOOKS:

1. Bhandari. V.B," Design of Machine Elements ", Fifth Edition McGraw Hill Education (India) Private Limited, , Noida 2020.
2. Richard G. Budynas and Keith J. Nisbett "Shigley's Mechanical Engineering Design",11th Edition, McGraw Hill, 2020.
3. Sharma P.C and D.K Sharma, "Machine Design", Agrawal - Kataria and Sons Publications. New Delhi, 2014.

REFERENCES:

1. Dexter S Kimball and John H Barr ,"Elements of Machine Design", Maxwell Press, 2022.
2. Khurmi R.S.," A Textbook Of Machine Design ", 25th edition, S Chand, 2020.
3. Robert C. Juvinall, Kurt M. Marshek," Machine Component Design ", Willey Indian Edition, 2016.
4. Robert L. Norton," Machine Design ", 5th Edition Pearson India, 2018.

E-RESOURCES:

1. http://www.nptelvideos.com/course.php?id=791& http://nptel.ac.in/courses/112105125
2. https://www.expresslibrary.mheducation.com/product/design-machine-elements50161125
3. https://www.machinedesign.com › basics-design › hydrodynamic-bearings
4. https://fac.ksu.edu.sa › sites › default › files › mechanical-design-shigley.
5. https://www.teacheron.com/design_of_machine_elements-tutors.

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	1						2	2		3	3	1
2	3	2	1						1			2	3	
3	3	2	1						2	1		1	3	1
4	3	2	1									1	3	
5	3	1	1						1			1	3	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

MN22402 FLUID MECHANICS AND THERMAL SCIENCE

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. To impart the basic knowledge of fluids in static, kinematic and dynamic equilibrium conditions.
2. To gain the knowledge of the applicability of physical laws in addressing the problems of fluid flow.
3. To enable the students for analyzing the various energy transferring / transforming equipment using first law of thermodynamics
4. To familiarize the students to understand the fundamentals of thermodynamics using the second law and to perform thermal analysis.
5. To impart the knowledge of primary techniques for cooling electronic devices and thermal management of equipment.

UNIT I FLOW CHARACTERISTICS 12

Introduction to Fluid Mechanics. Pressure measurement using U-tube manometers. Flow characteristics –Concept of control volume and system - Reynold's transportation theorem - Continuity equation, energy equation and momentum equation – Applications- Orifice meter and Venturimeter.

UNIT II FLOW THROUGH CIRCULAR CONDUITS 12

Hydraulic and energy gradient - Laminar flow through circular conduits and circular annuli-Boundary layer concepts – types of boundary layer thickness – Major and minor losses - Darcy Weisbach equation –friction factor- Moody diagram- Commercial pipes – Flow through pipes in series and parallel.

UNIT III FIRST LAW OF THERMODYNAMICS 12

Basic concepts, System and their types, reversible and irreversible processes, Heat and work transfer, Zeroth law of thermodynamics– Concept of temperature and thermal equilibrium. First law of thermodynamics – application to non-flow and steady flow processes – unsteady flow processes (descriptive only).

UNIT IV SECOND LAW AND PROPERTIES OF PURE SUBSTANCE 12

Heat reservoirs - Heat Engine, refrigerator, and heat pump. Statements of second law and its corollaries - Clausius inequality. Concept of entropy, T-S diagram, T ds equations. Entropy changes for ideal gases- different processes, principle of increase in entropy. Formation of steam and its thermodynamic properties, P-v, P-T, T-v, T-s, h-s diagrams - PVT surface. Use of Steam Table and Mollier Chart.

UNIT V HEAT TRANSFER 12

Basic Concepts of Conduction, Convection and Radiation. Thermal management in Electronic and Mechanical devices. Thermoelectric cooling and its principles - Applications in electronic systems - Peltier effect of cooling in semiconductors - Cooling of automotive electronic devices - Trends in thermal management - Heat Pipe.

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Acquire a basic knowledge of fluids in static, kinematic and dynamic equilibrium.	3
CO2	Gain the knowledge of the applicability of physical laws in fluid flow through circular conduits.	3

CO3	Analyze various energy transferring / transforming equipment using first law of thermodynamics	3
CO4	Analyze various Energy Transferring / transforming equipment using Second law of thermodynamics and able to analyze the properties of steam with the help of steam table and charts.	4
CO5	Gain the Knowledge of necessity of cooling of electronic components and heat transfer methods, Thermoelectric cooling principles, applications in electronics systems.	3

TEXTBOOKS:

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2019.
2. White, F.M., Henry Xue "Fluid Mechanics", Tata McGraw Hill, 9th Edition, New Delhi, 2022.
3. Nag P.K "Engineering Thermodynamics" 5th Edition, Tata McGraw-Hill, New Delhi, 2013.
4. Nag, P.K., "Heat Transfer", Tata McGraw Hill, New Delhi,3rd Edition, 2011.

REFERENCES:

1. Jain A. K. "Fluid Mechanics", Khanna Publishers, 2010.
2. Yunus A. Cengel and Michael A.Boles "Thermodynamics Engineering approach", 8th Edition Tata McGraw hill Publications. 2014
3. Rajput R.K., " Thermal Engineering", Lakshmi Publications, 10th Edition, 2017.
4. Younes Shabany, "Heat Transfer: Thermal Management of Electronics", CRC Press, 2010.

E-RESOURCES:

1. https://nptel.ac.in/courses/112104118
2. https://archive.nptel.ac.in/courses/112/105/112105171/
3. https://onlinecourses.nptel.ac.in/noc23_me31/preview

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3		1										1	2
2	3	2	1										1	1
3	3	2	1										2	1
4	3	2	1										2	1
5	3		1										1	1

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

MN22403 OPERATIONS RESEARCH AND MANAGEMENT

L	T	P	C
3	1	0	4

COURSE OBJECTIVES:

1. Define and formulate linear programming problems and appreciate their limitations.
2. Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained.
3. Formulate Network models for service and manufacturing systems, and apply operations research techniques.

UNIT I LINEAR PROGRAMMING METHODS 12

Overview of operations research - Concepts and steps in modelling - Linear programming and types - formulation - graphical method - simplex method - Big M method.

UNIT II LOGISTICS AND SEQUENCING MODELS 12

Logistics - Transportation model – Initial solution by North -West corner method – Least Cost method – VAM. Optimality test – MODI method. Assignment model – formulation – Balanced and unbalanced assignment problems. Sequencing – Problem with N jobs and 2 machines - 3 machines and 'M' machines.

UNIT III INVENTORY CONTROL AND JOB SCHEDULING 12

Inventory models – Economic order quantity models – Quantity discount models – Inventory control models in practice – Network diagrams - CPM and PERT networks – Critical path scheduling.

UNIT IV REPLACEMENT AND FACTORY MAINTENANCE ANALYSIS 12

Replacement and Maintenance analysis – Types of maintenance, types of replacement problem, determination of economic life of an asset, Replacement of an asset with a new asset – capital recovery with return and concept of challenger and defender - Simple probabilistic model for items which fail completely.

UNIT V INDUSTRIAL SIMULATION 12

Usefulness – Analytical complexity – Effect of change – Time compression – Physical simulation – state variables – static and dynamic models – Monte Carlo technique – Normal distribution – Types of simulation – Languages.

TOTAL : 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Identify, develop and evaluate** LP models to achieve the best solution and for process improvement.	3
CO2	**Compare and contrast** the significance of transportation and assignment problems in logistics.	3
CO3	**Select** the suitable methodology for real time problems in inventory and management.	4
CO4	**Apply** suitable technique to perform the requisite type of maintenance.	3
CO5	**Explain** simulation techniques used in industries for scheduling.	2

TEXTBOOKS:

1. Panneerselvam. R., "Operation Research", Prentice Hall of India Pvt Ltd, 2016.
2. Taha H.A., "Operations Research", 10th Edition, Prentice Hall of India, 2016.

REFERENCES:

1. Rama Murthy R, "Operations Research", 2nd Edition, New Age International Publisher, 2007.
2. Hira and Gupta "Problems in Operations Research", S. Chand and Co.2008.
3. Wagner, "Operations Research", Prentice Hall of India, 2000.

E-RESOURCES:

1. https://nptel.ac.in/courses/110/106/110106062/
2. https://nptel.ac.in/courses/112/106/112106134/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1	3	3	1										1	2
2	3	2	1										1	2
3	3	2	1										1	1
4	3	2	1										1	1
5	3	2	1										1	2

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

MN22408 **HYDRAULICS AND PNEUMATICS FOR AUTOMATION: THEORY AND PRACTICES**

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. To understand the fundamental principles and operations of hydraulic and pneumatic components.
2. To design and analyze fluid power circuits for industrial automation.

UNIT I HYDRAULIC SYSTEM COMPONENTS 11

Fluid power systems - hydraulic fluids - Pascal's law - Darcy's equation – Losses in valves and fittings. Hydraulic power source - pumping theory – pumps classification - construction, working, performance and selection. Hydraulic actuators – linear & rotary. Control components – directional, flow and pressure control valves - types, working principle and applications. Electro-hydraulic circuits. Servo systems.

UNIT II PNEUMATIC SYSTEM COMPONENTS 09

Compressors - types and working principle. Filter, Regulator, Lubricator, Muffler, Air control valves, Quick exhaust valves, Pneumatic actuators, Servo valves. Fluid power ANSI symbol. Electronics in automation – PLC and Micro controller. Electro-pneumatic circuits.

UNIT III FLUID POWER ACCESSORIES AND MAINTENANCE 10

Accessories - Accumulators and their applications, Pressure intensifier, Pressure switches, Electrical switches, Limit switches, Relays. Air-over oil system, Hydrostatic transmission. Fault finding and maintenance of fluid power systems. Low cost automation.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

1. Design of pneumatic circuit using cascade method
2. Design of electro-pneumatic circuits using electrical timers and counters
3. Design of pneumatic circuit using Programmable Logic Controller (PLC)
4. Design of hydraulic circuit for synchronizing the linear actuators
5. Design of hydraulic circuit for controlling rotary actuators
6. Design of hydraulic circuit using Programmable Logic Controller (PLC)
7. Design and simulation of meter-in and meter-out circuits
8. Design and simulation of pump unloading circuit
9. Design and simulation of counterbalance circuit
10. Design and simulation of cascade circuits

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Describe** the working and **calculate** the performance of the hydraulic components.	2
CO2	**Explain** the working of components used in pneumatic systems.	2
CO3	**Describe** the working of accessories used in fluid power system.	2
CO4	**Design** a fluid power circuit using various controls for different industrial applications	3
CO5	**Simulate** and **analyze** fluid power circuits using software tools	4

TEXTBOOKS:

1. Anthony Esposito, Fluid Power with Applications, Pearson Education, 7th Edition, 2009.
2. James L. Johnson, Introduction to Fluid Power, Delmar Thomson Learning, 2002.

REFERENCES:

1. Dudelyt, A Pease and John J.Pippenger, Basic Fluid Power, Prentice Hall, 1987.
2. Majumdar, S.R., Oil Hydraulics Systems-Principles and Maintenance, Tata McGraw Hill, 2007
3. Majumdar, S.R., Pneumatic Systems-Principles and Maintenance, Tata McGraw Hill, 2007.
4. Micheal J, Pinches and Ashby, J.G., Power Hydraulics, Prentice Hall, 1989.
5. ShanmugaSundaram, K.,Hydraulic and Pneumatic controls, S. Chand limited, 2006.
6. Mechatronics training practice module, FESTO manual Germany, 2011.
7. Automation Lab Manual prepared by Faculty of Mechanical Engineering, Sri Venkateswara College of Engineering.

E-RESOURCES:

1. NPTEL Course - https://nptel.ac.in/courses/112105046/

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	3	1											2	3
2	3													3
3	3													3
4	3		3		3				3	3			3	3
5	3		3		3				3	3			3	3

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
1.	Basic pneumatic trainer kit	1 No.
2.	Electro pneumatic trainer kit	1 No.
3.	Electro pneumatic trainer kit with PLC	1 No.
4.	Basic hydraulic trainer kit	1 No.
5.	Electrohydraulic trainer kit with PLC	1 No.
6.	Automation studio software	5 Licenses
7.	Fluidsim software	5 Licenses
8.	Personal computers	10 No.
9.	Compressor – 10 bar	1 No.

MN22409 **METROLOGY AND INSTRUMENTATION: THEORY AND PRACTICES**

L	T	P	C
2	0	2	3

COURSE OBJECTIVES:

1. To understand the basic principles involved and provide practical exposure on the use in linear, angular and form measurements
2. To explain the principles and provide practical exposure on the advanced measuring devices.
3. To explain the principles and provide practical exposure on the use of various instruments to measure process parameters.

UNIT I INTRODUCTION TO METROLOGY, LINEAR AND ANGULAR MEASUREMENTS **10**

Introduction to Metrology – Need – Precision and Accuracy, Errors in Measurements, Comparators – Mechanical, Electrical & Optical. Interchangeability - limits, fits and tolerances, Limit gauges, Taylor's principle of gauge design. Calibration, Sensitivity, readability & repeatability.

Linear measurement - Vernier calipers – Vernier height gauge- Vernier depth gauge - Micrometers – Digital calipers - Slip gauges.

Angular Measurement - Angular measuring instruments – Types – Bevel protractor, Spirit levels, Sine bar – Sine center – Sine table – Angle Dekkor - Autocollimator.

UNIT II FORM & PROCESS PARAMETERS MEASUREMENT **10**

Form Measurement - Measurement of surface finish – Surf Tester. Screw thread measurement – Minor diameter & Effective diameter – Two wire method. Gear measurement - Gear terminology - Errors in gears – Pitch & Tooth thickness measurement - Parkinson's gear tester.

Measurement of Force – Load cells – Hydraulic & Pneumatic load cells – LVDT. Basics of Torque & Power measurement. Flow measurement – Differential pressure flow meter, Magnetic flow meter – Ultrasonic flow meter. Temperature measurement - Thermocouples – Radiation pyrometer – Infrared temperature sensor

UNIT III ADVANCES IN METROLOGY **10**

Interferometry – Types of Interferometers – Michelson interferometer – NPL flatness interferometer. Laser metrology - Basic concept of lasers - Advantages of Laser – Laser Interferometers – Types – DC and AC lasers interferometer – Applications. Coordinate Measuring Machines - Types of construction – Probes. CNC CMM, Machine vision system – Image acquisition & Image processing.

LABORATORY COMPONENT

LIST OF EXPERIMENTS

1. Measurement of lengths, heights, diameters by vernier calipers, micrometers etc.
2. Measurement of bores by bore dial gauge / telescopic gauge
3. Inspection of gear parameters by gear tooth vernier caliper / flange micrometer.
4. Use of spirit level in finding the straightness of a bed and flatness of a surface.
5. Surface roughness measurement with roughness measuring instrument.
6. Angle and taper measurements with bevel protractor, sine bars, rollers and balls.
7. Linear and angular measurement using CMM
8. Force, torque and displacement measurement using transducers

9. Temperature and pressure measurement using transducers
10. Measurement of flatness using Autocollimator/Optical interferometer
11. Calibration of measuring instruments: Vernier caliper/ Micrometer/ Dial gauge/ Vernier height gauge/ Bevel protector.
12. Straightness measurement using Autocollimator

TOTAL: 60 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	**Understand** the working principles of linear and angular measuring instruments.	**2**
CO2	**Acquire** an overview of mechanical measurement systems and principle of instruments for motion and dimension measurement.	**2**
CO3	**Select** the suitable transducer to perform the real time measurements.	**3**
CO4	**Calibrate** the measuring devices suitable for industrial measurements.	**4**
CO5	**Use** the advanced systems for real time and industrial measurements.	**3**

TEXTBOOKS:

1. Gupta. I.C., "Engineering Metrology", 7th edition, Dhanpatrai Publication, 2019.
2. Jain R.K "Engineering Metrology", Khanna Publishers, 1st Edition, 2021.

REFERENCES:

1. A K Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation", Dhanpat Rai & Co (p) Ltd, 2021.
2. Beckwith, Maragoni & Lienhard, "Mechanical Measurements", Pearson Education, 6th Edition, 2007.
3. Mahajan M, "Textbook of Metrology", Dhanpat Rai & Co (p) Ltd, 2012.
4. R.K. Rajput, "Metrology and Instrumentation", S.K. Kataria& Sons, 2016.
5. Robert B. Northrop, "Introduction to Instrumentation and Measurements", CRC Press, 2018.

E-RESOURCES:

1. http://home.iitk.ac.in/~nsinha/Metrology.pdf
2. https://nptel.ac.in/courses/112106179
3. https://swayamprabha.gov.in/index.php/program_data/flipMore/M74/11

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1	2				2				2			2		
2	2	2	2		2	2				2			2	
3	2		2		2				2			2	2	2
4	3		3		3	3			3			2	3	3
5	2		2		3	2			2				2	2

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
1.	Micrometer	10
2.	Vernier Caliper	10
3.	Vernier Height Gauge	3
4.	Vernier Depth Gauge	3
5.	Slip Gauge Set	6
6.	Gear Tooth Vernier	2
7.	Sine Bar	2
8.	Floating Carriage Micrometer	1
9.	Profile Projector / Tool Makers Microscope	Each 1
10.	Mechanical / Electrical / Pneumatic Comparator	Each 1
11.	Autocollimator	1
12.	Temperature Measuring Setup	3
13.	Force Measuring Setup	1
14.	Torque Measuring Setup	1
15.	Coordinator Measuring Machine	1
16.	Surface finish measuring equipment	2
17.	Bore gauge	1
18.	Telescope gauge	1 set

ME22411 **COMPUTER AIDED MODELLING LABORATORY**
(Common to ME & MN)

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

1. Create 3D models of parts and assembly, and exploded views of assembly using CAD software.
2. To provide knowledge on three-dimensional model of simple mechanism and animation using CAD software.
3. To expose the knowledge to prepare the technical documents for the given components using software.

LIST OF EXPERIMENTS:

1. Introduction to modeling software and Study of Drawing Sheet Layout and Drawing Standards. Sketch, Solid modeling- Extrude, Revolve, Sweep.
2. Solid modeling: Variational Sweep, Helical Sweep, Rotational Blend.
3. Solid modeling: Blend and Parametric modeling- conversion of STL format.
4. Surface modeling: Extrude, Sweep, Trim, Mesh of curves and Free form.
5. Create a surface model of Aero Foil / Blower upper housing / Bend Pipe with flange.
6. Construct a three-dimensional assembly model of Screw Jack. **
7. Create a three-dimensional assembly model of Flange / Universal Coupling apply**
8. Create a three-dimensional assembly model of kinematic mechanism and animate its working using modeling software.
9. Introduction to Generative Design for Weight Reduction of a support frame.
10. Generative Design for Weight Reduction of cycle frame.

**** Modelling of individual elements of the Mechanical equipment and assembling the same as per given standard by applying concepts of fits, limits, and tolerances – as Team exercises**

TOTAL 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Interpret the given 2D drawing and create a 3D part using 3D modeling software.	3
CO2	Create a 3D assembly in the assembly module using the 3D parts created in the part modeling module.	3
CO3	Generate 2D detailed drawing for the given parts & assembly models.	3
CO4	Analyze and interpret the kinematic links using 3D modeling software.	4

REFERENCES:

1. Creo Parametric 4.0 Tutorials by Roger Too good, SDC Publications, 2017.
2. Creo Parametric 4.0 for Designers BY Sham Tickoo, BPB Publications, 2018.
3. Machine Drawing by K.R. Gopalakrishnan, 2018.
4. Machine Drawing by K. L. Narayana, New Age Publications, 2012.

E-RESOURCES:

1. https://grabcad.com/tutorials/basic-creo-tutorials
2. https://support.ptc.com/help/creo/creo_pma/r9.0/usascii/index.html#page/part_modeling/part_modeling/partmodeling.html#
3. https://www.youtube.com/watch?v=bYKbYLfpk6k
4. https://www.youtube.com/watch?v=gJLAM54Vf-w
5. https://youtu.be/lhq-O5w6STU

COURSE ARTICULATION MATRIX:

COs	POs												PSOs	
	1	2	3	4	5	6	7	8	9	10	11	12	1	2
1.					3				2	2			2	
2.					3				2	2			3	
3.					3				2	2			3	
4.					3				2				3	

1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No	ITEM DESCRIPTION	QUANTITY
1.	Desktop Computers	30
2.	PTC Creo parametric	45 Licenses

ME22412 FLUID AND THERMAL ENGINEERING LABORATORY

L	T	P	C
0	0	3	1.5

COURSE OBJECTIVES:

1. To gain the experimental knowledge in flow measurements using different devices.
2. To study the various losses in pipes.
3. To gain experimental knowledge in the performance characteristic of pumps and turbines.
4. To study the Performance of petrol, diesel engine and steam generator and refrigeration system.
5. To Study the characteristics of fuels/Lubricants used in IC Engine, performance of compressor.

LIST OF EXPERIMENTS:

1. Determination of the Coefficient of discharge of given Venturimeter and Orifice meter
2. Determination of friction factor for a given set of pipes
3. Conducting experiments and drawing the characteristic curves of centrifugal/submersible pumps
4. Conducting experiments and drawing the characteristic curves of reciprocating pump
5. Conducting experiments and drawing the characteristic curves of Gear pump
6. Conducting experiments and drawing the characteristic curves of Pelton wheel
7. Determination of viscosity and flash & fire point of fuels/Lubricants.
8. Heat balance/retardation test on diesel engine.
9. Performance test on diesel engine
10. Performance test on air compressor
11. Performance test on refrigeration system
12. Determination of heat transfer coefficients.

TOTAL: 45 PERIODS

CO No.	COURSE OUTCOMES	RBT Level
At the end of the course, students will be able to:		
CO1	Calculate the coefficient of discharge for the different flow measuring equipment.	3
CO2	Analyse the performance of various pumps and turbines.	4
CO3	Analyse the performance of diesel engine, refrigeration and compressor.	4
CO4	Determine the viscosity, flash and fire point of fuels/lubricants.	3

REFERENCES:

1. Modi P.N. and Seth, S.M. "Hydraulics and Fluid Mechanics", Standard Book House, New Delhi, 2019.
2. Robert W.Fox, Alan T. McDonald, Philip J.Pritchard, “Fluid Mechanics and Machinery”, 2011
3. Rajupt. R.K., "Thermal Engineering", Laxmi Publications, 10th Edition, 2017.
4. Ganesan, V "Internal Combustion Engines", 4th Edition, Tata Mcgraw-Hill, 2012.

E-RESOURCES:

1. https://fm-nitk.vlabs.ac.in/List%20of%20experiments.html

COURSE ARTICULATION MATRIX:														
COs	**POs**												**PSOs**	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
1.	3	3										3		3
2.	3	3										3		3
3.	3	3										3		3
4.	3	3										3		3
5.	3	3										3		3
1: Slight (Low), 2: Moderate (Medium), 3: Substantial (High)														

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS

SL.No.	ITEM DESCRIPTION	QUANTITY
1.	Venturi meter and Orifice meter setups	Each 1
2.	Pipe Flow analysis setup	1
3.	Centrifugal pump setup	1
4.	Reciprocating pump setup	1
5.	Gear pump setup	1
6.	Pelton wheel setup	1
7.	Apparatus for Flash and Fire Point and viscometer	1
8.	4-stroke Diesel Engine with hydraulic loading	1
9.	Steam Boiler setup	1
10.	Air compressor	1
11.	Refrigeration test rig	1