N.B.K.R. INSTITUTE OF SCIENCE & TECHNOLOGY

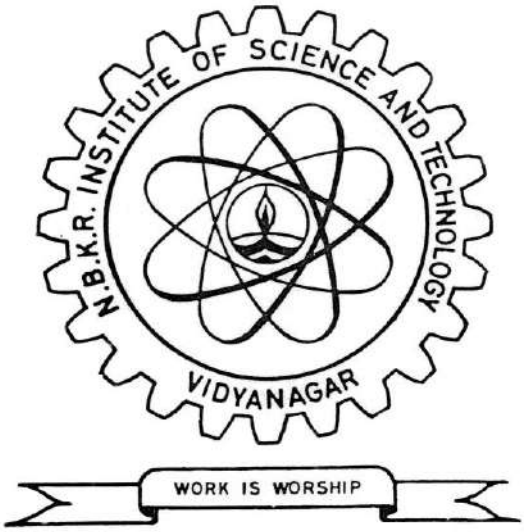
(AUTONOMOUS)

COLLEGE WITH POTENTIAL FOR EXCELLENCE (CPE)

Affiliated to JNTUA, Ananthapuramu

Re-Accredited by NAAC with 'A' Grade

B.Tech. Courses Accredited by NBA under TIER-I



SYLLABUS

B.TECH. DEGREE COURSE

I B.TECH

I & II Semesters

MECHANICAL ENGINEERING

(With effect from the batch admitted in the academic year 2020-2021)

VIDYANAGAR - 524413

SPSR Nellore-Dist. Andhra Pradesh

www.nbkrist.org

INSTITUTE VISION

To emerge as a comprehensive Institute that provides quality technical education and research thereby building up a precious human resource for the industry and society.

INSTITUTE MISSION

- To provide a learner-centered environment that challenges individuals to actively participate in the education process.

- To empower the faculty to excel in teaching while engaging in research, creativity and public service.

- To develop effective learning skills enabling students pick up critical thinking thus crafting them professionally fit and ethically strong.

- To share human and academic resources with industries, schools and public agencies through partnerships and outreach activities.

VISION OF THE DEPARTMENT

To become an excellent centre for technical education and research in the field of mechanical engineering to meet the societal, regional, national and global challenges.

MISSION OF THE DEPARTMENT

M1: To impart quality technical education and transform bud engineers into an effective and responsible engineers to work with the current technologies in multi-cultural and multi-discipline environment.

M2: To encourage the students to develop their creativity in the field of mechanical engineering by providing modern laboratory facilities with hands on training and contemporary curriculum.

M3: To develop the interaction with the Industry experts to gain practical knowledge.

M4: To provide best teaching & learning practices as well as creating opportunities for Research, maximise student results and placements.

M5: To inculcate and promote lifelong learning skills, problem solving skills, leadership qualities and team work.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: A strong foundation to access, analyze, plan and implement their knowledge in basic sciences & mathematics, core and interdisciplinary courses.

PEO 2: Graduate will be in a position to work with the members of multi-disciplinary teams and can play a leading role in handling the technical issues.

PEO 3: Graduates will have capability to work with modern engineering tools, software and equipment under the realistic constraints.

PEO 4: Graduates will engage in lifelong learning skills with research attitude and social responsibility.

PROGRAM OUTCOMES(POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review the research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO11 **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.

PO12 **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.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1 Solve engineering problems in the area of Robotics and Automation.

PSO2 Design, Simulate and Analyze using CAD/CAM/CAE tools.

NBKR INSTITUTE OF SCIENCE & TECHNOLOGY: VIDYANAGAR (AUTONOMOUS)

(AFFILIATED TO JNTUA ANANTAPURAMU)

I YEAR OF FOUR YEAR B.TECH DEGREE COURSE – I SEMESTER

MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION AND EVALUATION

(With effect from the academic year 2020-2021)

S.No	Course Code	Course Title	Instruction Hours/Week			Credits	Evaluation								
							Sessional Test-I		Sessional Test-II		Total Sessional Marks (Max. 40)	End Semester Examination			Maximum Total Marks
		THEORY	L	T	D/P		Duration In Hours	Max. Marks	Duration In Hours	Max. Marks		Duration In Hours	Max. Marks		100
1	20SH1101	Communicative English	3	-	-	3	2	40	2	40	0.8*Best of two+0.2*least of two	3	60		100
2	20SH1103	Engineering Chemistry	2	1	-	3	2	40	2	40		3	60		100
3	20SH1105	Engineering Mathematics – I	2	1	-	3	2	40	2	40		3	60		100
4	20CS1101	Programming For Problem Solving	3	-	-	3	2	40	2	40		3	60		100
		Laboratories													
5	20SH11P1	Communicative English Laboratory			3	1.5				40		3	60		100
6	20SH11P3	Engineering Chemistry Laboratory	-	-	3	1.5	-	-	-	40		3	60		100
7	20ME11P1	Computer Aided Engineering Drawing Laboratory	-	-	6	3	-	-	-	40		3	60		100
8	20CS11P1	Programming for Problem Solving Laboratory			3	1.5				40					
		Total	**09**	**02**	**15**	**19.5**	**-**	**-**	**-**	**320**		**-**	**480**		**800**

20SH1101 COMMUNICATIVE ENGLISH

(Common to All Branches)

Course Category:	Basic Sciences	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practical:**	3-0-0
Pre-requisite:	Basic Level of LSRW Skills	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives	Students undergoing this course are expected: 1. To develop basic writing skills in English. 2. To achieve specific linguistic and communicative competence. 3. To acquire relevant skills and make use of them effectively in practical working context. 4. To inculcate the habit of reading and make aware of appropriate reading strategies. 5. To learn writing paragraphs effectively with unity and coherence. 6. To learn writing of simple and analytical essays.		
Course Outcomes	On successful completion of this course, the students will be able to:		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Identify activity-based learning methods to ensure that they would be engaged in use of language.	K3
	CO2	Demonstrate effective listening skills for better comprehension of academic lectures and English spoken by the native speakers.	K2
	CO3	Apply knowledge of grammatical structures and vocabulary and encourage their appropriate usage in speaking and writing.	K3
	CO4	Contrast graphic elements used in academic texts and produce a coherent paragraph construing a figure/graph/chart/table	K2
	CO5	Evaluate reading/listening texts and to write summaries based on global comprehension of these texts.	K4
	CO6	Develop appropriate reading strategies of comprehension in various academic texts and authentic materials and comprehend, discuss and respond to academic texts orally and in writing.	K3

Course Content	**UNIT-I** **Lesson: On the Conduct of Life: William Hazlitt** **Writing:** Paragraph Writing: Sentence Structures - use of phrases and clauses in sentences - importance of proper punctuation - creating coherence- beginnings and endings of paragraphs - introducing the topic, summarizing the main idea and/or providing a transition to the next paragraph **Grammar:** Content words and Function words: Word Forms: Verbs, Nouns, Adjectives and Adverbs; Nouns: Countable and Uncountable; singular and plural; Basic Sentence Structures; Simple Question form - Wh-questions; Word Order in Sentences **Vocabulary :** Word Formation - Suffixes **UNIT-II** **Lesson: The Brook: Alfred Tennyson** **Writing:** Descriptions: Nature and style of sensible writing - Describing - Defining - Classifying - Providing examples and evidence - Writing introduction and conclusion **Grammar:** Cohesive devices - Linkers, Sign posts and transition signals; Use of Articles and Zero Article, Prepositions, **Vocabulary:** Word Formation - Prefixes **UNIT-III** **Lesson: The Death Trap: Saki** **Writing:** Drafting of Public Speech**:** Introduction - Structure - Content - Informing facts - Conclusion **Grammar:** Pronoun-Agreement, Subject-Verb Agreement **Vocabulary:** Synonyms **UNIT-IV** **Lesson: Innovation: Muhammad Yunus** **Writing:** Information Transfer: describe, compare, contrast, and identify significance/trends based on information provided in figures/charts/graphs/tables. **Grammar:** Quantifying expressions - Adjectives and Adverbs; Comparing and Contrasting; Degrees of Comparison **Vocabulary:** Antonyms

	UNIT-V **Lesson: Politics and the English Language: George Orwell** **Writing:** Letter Writing: Official Letters and E-mail letters **Grammar:** Verbs - Tenses - Active Voice and Passive Voice, Question Tags, Reported Speech **Vocabulary:** One - Word Substitutes **UNIT –VI** **Reading:** Comprehension: Different Reading Strategies - Skimming - Scanning - Inferring, Predicting and responding to content - Guessing from context and vocabulary extension. **Writing:** Essay writing: Writing structured essays on specific topics - introducing the issue - analyzing and arguing - creating coherence usage of proper punctuation - importance of conclusion **Grammar :** Editing short texts - identifying and correcting common errors in grammar and usage (articles, prepositions, tenses, subject verb agreement) **Vocabulary:** Common Abbreviations
TEXT BOOKS:	1. Language and Life: A Skills Approach - I Edition 2018, Orient Black Swan
REFERENCES:	1. Bailey, Stephen. *Academic writing: A hand book for international students*. Routledge, 2014. 2. Chase, Becky Tarver. *Pathways: Listening, Speaking and Critical Thinking,* Heinley ELT; 2nd Edition, 2018. 3. Skillful Level 2 Reading & Writing Student's Book Pack (B1) Macmillan Educational. 4. Raymond Murphy's *English Grammar in Use* Fourth Edition (2012) E-book 5. Hewings, Martin. *Cambridge Academic English (B2)*. CUP, 2012.
E-Resources:	www.englishclub.com www.easyworldofenglish.com www.languageguide.org/english www.bbc.co.uk/learningenglish www.eslpod.com/index.html www.myenglishpages.com

20SH1103 ENGINEERING CHEMISTRY

(Common to CE and ME)

Course Category:	Basic science	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practical:**	2-1-0
Pre-requisite:	Fundamental concepts of Chemistry	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

<table>
<tr><td>Course Objectives</td><td colspan="3">

To familiarize engineering chemistry and its applications
To impart the concept of soft and hard waters, softening methods of hard water
To train the students on the principles and applications of electrochemistry, polymers, fuel chemistry and cement

</td></tr>
<tr><td rowspan="8">Course Outcomes</td><td colspan="3">On successful completion of this course student will be able to:</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>Explain the principles of reverse osmosis and electro dialysis</td><td>K2</td></tr>
<tr><td>CO2</td><td>Apply Nernst equation for calculating electrode and cell potentials</td><td>K3</td></tr>
<tr><td>CO3</td><td>Demonstrate the factors affecting corrosion and corrosion prevention methods</td><td>K2</td></tr>
<tr><td>CO4</td><td>Differentiate between thermoplastics and thermosetting plastics</td><td>K4</td></tr>
<tr><td>CO5</td><td>Solve the numerical problems based on Calorific value</td><td>K4</td></tr>
<tr><td>CO6</td><td>Enumerate the reactions at setting and hardening of cement</td><td>K2</td></tr>
<tr><td>Course Content</td><td colspan="3">
UNIT – I
WATER TECHNOLOGY:
Introduction-Hardness of water, types of hardness, units of hardness, disadvantages of hard water, Estimation of hardness of water by EDTA Method, Analysis of water-Alkalinity and Dissolved oxygen - Boiler troubles - scale and sludge, Priming and foaming, caustic embrittlement and Boiler corrosion-Treatment of water for Domestic purpose- Industrial water treatment – zeolite and ion-exchange processes - desalination of brackish water, reverse osmosis (RO) and electro dialysis.

UNIT – II

ELECTRO CHEMISTRY AND APPLICATIONS:
Introduction to Electro chemistry, Electrodes – concepts, Electrode potential, Nernst equation, reference electrodes (Calomel electrode and glass electrode), electrochemical cell, cell potential calculations, numerical problems. Batteries- Primary cells – Zinc-air battery.
Secondary cells – lead acid and lithium ion batteries-working of the batteries including cell reactions.
</td></tr>
</table>

Fuel cells- hydrogen-oxygen fuel cell– working of the cell. Potentiometry –Basic concepts, potentiometric titration (strong acid *vs* strong base).
Conductometry –Basic concepts, conductometric titrations (strong acid *vs* strong base & weak acid *vs* strong base).
P^H metry-Basic concepts and applications.

UNIT – III

CORROSION:

Introduction to corrosion, definition, types of corrosion, Mechanism of corrosion- metal oxide formation by dry corrosion, Pilling Bedworth ratios and uses and electrochemical theory of corrosion, differential aeration cell corrosion, galvanic corrosion, Factors affecting the corrosion, prevention methods of corrosion- Cathodic protection (Sacrificial anodic protection and Impressed current cathodic protection) and Metallic coatings -Electroplating and Electro less plating.

UNIT – IV

POLYMER CHEMISTRY:

Introduction to polymers, Polymerisation and Types of polymerisation (addition, condensation and co-polymerisation)-Poly dispersibility index, Measurement of average molecular weight of polymer.
Plastomers -Thermoplastics and Thermo setting plastics, Preparation, properties and applications of PVC, Bakelite, Urea-Formaldehyde and Nylons.
Elastomers – Preparation, properties and applications of Buna S, Buna N and Thiokol.

UNIT – V

FUEL TECHNOLOGY:

Chemical fuels – Introduction, classification, characteristics of a good fuel, calorific value, determination of calorific value (Bomb and Boy's gas calorimeters), numerical problems based on calorific value.
Solid Fuels–Types, ranking of coal and Analysis of coal (Proximate and Ultimate analysis). **Liquid Fuels -**Refining of petroleum, knocking and anti-knock agents, Octane and Cetane numbers.
Gaseous Fuels-L.P.G, Water gas, producer gas and Flue gas analysis by Orsat's apparatus.

UNIT – VI

ADVANCED ENGINEERING MATERIALS:

Refractories- Introduction, Classification, properties-Refractoriness, Refractoriness under load, Dimensional stability, Porosity and Thermal spalling- criteria for a good Refractory material and Applications.
Lubricants- Introduction, Classification, Functions of lubricants, Mechanism, Properties of lubricants-Viscosity, viscosity index, Flash and Fire points, Cloud and Pour points and Applications.
Building materials- Cement – Introduction, classification, Portland Cement - constituents, Setting and Hardening of Cement-special cements-water proof cement, white cement.

TEXT BOOKS:	1. Jain and Jain, Engineering Chemistry, 16 Ed., Dhanpat Rai Publishers, 2013. 2. Peter Atkins, Julio de Paula and James Keeler, Atkins' Physical Chemistry, 10 Ed., Oxford University Press, 2010.
REFERENCES:	1. K N Jayaveera, G V Subba Reddy and C Rama Chandraiah, Engineering Chemistry 1 Ed. Mc Graw Hill Education (India) Pvt Ltd, New Delhi 2016 2. Dr. S.S. Dara and Dr S.S Umare, A Text book of Engineering Chemistry, 1 Ed., Chand & Company Ltd., 2000. 3. K Sesha Maheswaramma and Mridula Chugh, Engineering Chemistry, 1 Ed., Pearson India Education Services Pvt. Ltd, 2016. 4. D. J. Shaw, Introduction to Colloids and Surface Chemistry, 4 Ed., Butterworth-Heineman, 2013.

20SH1105 ENGINEERING MATHEMATICS –I

(Common to All Branches)

<table>
<tr><td>Course Category:</td><td>Basic Sciences</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture-Tutorial-Practical:</td><td>2-1-0</td></tr>
<tr><td>Pre – requisite:</td><td>Intermediate Mathematics</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To make the student learn about:

1. The concepts of Newton’s law of cooling, Law of natural growth and decay.
2. Solving higher order differential equations with RHS of different types by using analytical techniques.
3. The concepts of first shifting theorem, Change of scale property, Laplace transformation of multiplied by t and division by t and transformation of derivatives and integrals.
4. The application of Solutions of Ordinary Differential Equations.
5. The basic concepts of Matrices.
6. Taylor’s and Maclaurin’s series, Maxima and Minima of the functions of two and three variables.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">After completing the course the student will be able to:
<table><tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr><tr><td>CO1</td><td>Develop skills in solving first order differential equations and its applications.</td><td>K3</td></tr><tr><td>CO2</td><td>Acquire knowledge in solving higher order differential equations by using various types.</td><td>K3</td></tr><tr><td>CO3</td><td>Acquire basic knowledge in Laplace transforms and their applications.</td><td>K3</td></tr><tr><td>CO4</td><td>Develop analytical skills in solving the Ordinary Differential Equations by using the Laplace transform technique.</td><td>K3</td></tr><tr><td>CO5</td><td>Understand effectively the analyzation of the Rank of the matrix, Consistency of system of linear equations, Eigen values and Eigen vectors.</td><td>K2</td></tr><tr><td>CO6</td><td>Analyze the Taylor’s and Maclaurin’s series and Maxima and Minima of the functions of two and three variables.</td><td>K4</td></tr></table></td></tr>
<tr><td></td><td colspan="3">UNIT - I

First order Differential Equations: Differential Equations of first order and first degree – exact, linear and Bernoulli. Applications to Newton’s law of cooling, Law of natural growth and decay.</td></tr>
</table>

Course Content	**UNIT - II** **Higher order Differential Equations:** Homogeneous linear differential equations of second and higher order with constant coefficients with R.H.S. of the type e^{ax}, $\sin ax$ or $\cos ax$, x^n, e^{ax} V and $x^n v(x)$.Method of Variation parameters. **UNIT - III** **Laplace Transformation:** Laplace Transformations of standard functions, Region of convergence, First shifting theorem, Change of scale property, Laplace transformation of multiple by t and division by t, Transformation of derivatives and integrals. **UNIT - IV** **Inverse Laplace Transformation:** Inverse transforms, Method of partial fractions, Shifting property, Inverse Laplace transform of amultiple by s and division by s, Inverse Laplace transform of derivatives and integrals, Convolution theorem. Application to Solutions of Ordinary Differential Equations. **UNIT - V** **Matrices:** Rank of Matrix by Echelon form, System of homogenous and non- homogenous linear equations, Eigen values and Eigen vectors and their properties. **UNIT - VI** **Differential Calculus:** Taylor's and Maclaurin's series , Maxima and Minima of function of two variables and Lagrangian method of multipliers with three variables only.
TEXTBOOKS:	1. Higher Engineering Mathematics - B.S.Grewal, Kanna Publishers, New Delhi. 2. Engineering Mathematics - B.V. Ramana, Tata McGraw-Hill Education Pvt. Ltd, New Delhi.
REFERENCES:	1. Higher Engineering Mathematics - H.K. Dass, Er. Rajnish Verma, S.Chand Publication, New Delhi. 2. Advanced Engineering Mathematics - N.P. Bali & M. Goyal, Lakshmi Publishers, New Delhi. 3. Advanced Engineering Mathematics - Erwin Kreyszig, Wiley, India

20CS1101 – PROGRAMMING FOR PROBLEM SOLVING

(MECHANICAL ENGINEERING)

Course Category:	Program Core	**Credits:**	3
Course Type:	Theory	**Lecture – Tutorial-Practical:**	3-0-0
Prerequisite:	Knowledge on Computer fundamentals and basic Mathematics	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

- To learn the procedure how to develop algorithms, representations and programming development steps
- To learn the basic building blocks of C language.
- Usage of C constructs (arrays, structures, pointers and file management) to develop various programs
- To create better awareness how effectively utilize the concepts of C for application development

Course Outcomes

Upon the successful completion of the course, the students will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Learn the fundamentals of programming development, structure of C and basic data types	K1
CO2	Use of operators in expression evaluation and construction of I/O Statements.	K3
CO3	Acquire knowledge on various control structures to develop simple programs	K3
CO4	Explore the concept of arrays, strings and its effective utilization	K1
CO5	Understand the concepts of Pointers and Functions for exploring the dynamic memory usage	K2
CO6	Explore the basics of Structures, Unions, File operations and supporting implementations	K1

Course Content

UNIT – I

INTRODUCTION: Algorithms, Flow charts, Program development steps.

FUNDAMENTALS OF C: History, Structure of a C program, Programming rules and execution. Character set, Delimiters, C keywords, Identifiers, Constants, Variables, Rules for defining Variables, Data types, Declaration and Initialization of Variables.

	UNIT – II **OPERATORS AND EXPRESSIONS:** Introduction, Operator Precedence and Associativity, Operator Types **INPUT AND OUTPUT IN C:** Formatted and Unformatted functions, Commonly used library functions. **UNIT – III** **DECISION STATEMENTS:** Introduction, Types of If statements, switch statement, break, continue, goto. **ITERATIVE STATEMENTS**: while, do-while and for loops. **UNIT – IV** **ARRAYS**: Definitions, Initialization, Characteristics of an array, Array Categories. **STRINGS:** Declaration and Initialization of strings, String handling functions. **STORAGE CLASSES**: Automatic, External, Static and Register Variables. **UNIT – V** **POINTERS:** Fundamentals, Declaration and initialization of Pointers, Arithmetic Operations, Pointers and Arrays. **FUNCTIONS:** Definition, Function Prototypes, Types of functions, Call by Value and Call by Reference, Recursion. **UNIT – VI** **STRUCTURES:** Definition, Declaration and Initialization of Structures. **UNIONS:** Definition, Declaration and Initialization of Union. **FILES:** Introduction, File Types, Basic operations on Files, File I/O, Command Line Arguments.
TEXT BOOKS:	1. Programming with ANSI & TURBO C by Ashok N.Kamthane, Pearson Education 2007
REFERENCES:	1. A Book on C by Al Kelley/Ira Pohl, Fourth Edition, Addison-Wesley.1999 2. Let Us C by Yashavant Kanetkar, BPB Publications. 3. Programming in ANSI C by Balaguruswamy 6th Edition, Tata McGraw Hill Education, 2012.
E-Resources:	1. **https://nptel.ac.in/courses** 2. **https://freevideolectures.com/university/iitm**

20SH11P1 COMMUNICATIVE ENGLISH LABORATORY
(Common to CE, ME, ECE)

<table>
<tr><td>Course Category:</td><td>Basic Sciences</td><td>Credits:</td><td>1.5</td></tr>
<tr><td>Course Type:</td><td>Practical</td><td>Lecture-Tutorial-Practical:</td><td>0-0-2</td></tr>
<tr><td>Pre-requisite:</td><td>Basic Level of LSRW skills</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">The main objective is to prepare the students to improve their communicative ability in English with emphasis on LSRW skills and enable them to communicate effectively in different socio-cultural and professional contexts.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon the successful completion of the course, the students will be able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Apply for the real life situations.</td><td>K3</td></tr>
<tr><td>CO2</td><td>Enhance the language competency and communicative level</td><td>K3</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3"><u>LIST OF ACTIVITIES</u>

1. Listening Skills
• Listening for Identifying key terms, understanding concepts
• Listening for specific information
• Listening for global comprehension and summarizing
• Listening to short audio texts and answering a series of questions.

2. Common Everyday Conversations:
(Asking and answering general questions on familiar topics such as home, family, work, studies and interests)

• Expressions in various situations
• Making requests and seeking permissions
• Interrupting and apologizing
• Role plays / Situational dialogues
3. Communication at Work Place:
• Introducing oneself and others
• Ice Breaking Activity and JAM Session
• Greetings
• Taking leave</td></tr>
</table>

	4. Debates & Group Discussions • Discussion in pairs/ small groups on specific topics • Short structured talks • Reporting/ summarizing **5. Presentations (Oral presentation, PPT & Poster presentation):** • Pre-planning • Nonverbal communication • Formal oral presentations on topics from academic contexts **6. Giving directions**
REFERENCES:	1. A Manual for English Language Laboratories: Dr. D. Sudha Rani, Pearson Publications 2. https://www.talkenglish.com/ 3. www.esl-lab.com 4. www.englishmedialab.com 5. www.englishinteractive.net

20ME11P1-COMPUTER AIDED ENGINEERING DRAWING LABORATORY

(Common to ME and CE)

Course Category:	Engineering Science	**Credits:**	3
Course type:	Practical	**Lecture- Tutorial-Practical:**	0-0-6
Prerequisite:	Geometrical Construction	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

<table>
<tr><th>Course</th><th>Marks</th><th colspan="2">Examination and Evaluation</th><th>Scheme of examination</th></tr>
<tr><td rowspan="4">Computer Aided Engineering Drawing-</td><td>60</td><td colspan="2">Semester end Examination for 3 hours duration in the CAD Laboratory</td><td>60 marks are allotted for the drawing examination during semester end.</td></tr>
<tr><td rowspan="3">40</td><td>20</td><td>Day-to-Day evaluation during the practice.</td><td>Marks are evaluated based on average performance of student in day-to-day exercises and finalized for 20 marks</td></tr>
<tr><td rowspan="2">20</td><td rowspan="2">Drawing examination</td><td rowspan="2">Two drawing examinations are conducted for 20 marks. 80% of better one and 20% of the other are added and finalized for 20 marks. Drawing examination-I: Shall be conducted just before I mid-term examinations. Drawing examination-II: Shall be conducted just before II mid-term examinations.</td></tr>
<tr><td></td></tr>
<tr><td>Course Objectives</td><td colspan="4">Students are made to understand / learn
❖ To enable the students with various concepts like dimensioning, construction of conic sections, polygons, cycloids and involutes.
❖ To impart and inculcate proper understanding of AutoCAD fundamentals.
❖ To apply the knowledge of AutoCAD for the projections of points, lines and solids.
❖ To know about sections and developments of solids.
❖ To improve the visualization skills with isometric projections.</td></tr>
<tr><td rowspan="4">Course Outcomes</td><td colspan="4">At the end of the course, the student will be able to</td></tr>
<tr><td>CO</td><td colspan="2">Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td colspan="2">Understand the conventions and methods of engineering drawings</td><td>K2</td></tr>
<tr><td>CO2</td><td colspan="2">Sketch the solutions to the problems on projection of points, lines, planes and solids</td><td>K5</td></tr>
</table>

	CO3	Demonstrate orthographic and Isometric principles	K2
	CO4	Understand and apply the knowledge of engineering drawing in modern CAD tools.	K2
Course Content	**INTRODUCTION TO CAD SOFTWARE:** **Introduction:** Importance of Computer Aided Drawing, software tool environment, drawing size and scale, main menu, tool bar and menus, co-ordinate system, drafting settings. **Creation and Editing:** Points, Lines, Poly lines, Polygons, Splines, circle, ellipse, text, move, copy, off-set, pan, mirror, rotate, trim, extend, break, chamfer, fillet, curves, block, layers, line representations, dimensioning and hatching. **GEOMETRICAL CONSTRUCTIONS, AND CONIC SECTIONS:** Importance of Drawing, Drawing Instruments, Sheet layout, BIS Conventions, Types of lines, Lettering, and dimensioning methods. **Geometrical Constructions:** Regular Polygons. **Conic Sections:** Introduction, Construction of Ellipse, Parabola and Hyperbola using Eccentricity method and Rectangular/ Oblong methods, Rectangular hyperbola. **SPECIAL CURVES:** Construction of Cycloidal curves – Cycloid, Epi-cycloid and Hypo-cycloid. Involutes – Involutes of circle and polygons. **PROJECTIONS OF POINTS AND LINES:** **Projections of Points:** Principles of projections, Planes of projection, Points in four quadrants. **Projections of Lines:** Line inclined to both the principal planes (first angle projection only). **PROJECTIONS OF PLANES:** **Projections of Planes:** Plane (triangle, square, rectangle, pentagon, hexagon and circular) inclined to both the principal planes. **PROJECTIONS OF SOLIDS:** **Projections of Solids:** Solids such as Prisms, Pyramids, Cylinders and Cones inclined to one plane.		
TEXT BOOKS:	1. Engineering Drawing, N.D. Bhat / Charotar Publishing House,. Gujarat, 53rd edition, 2014. 2. AutoCAD 2013 For Engineers and Designers, Sham Tickoo, Dream tech Press, 2013.		

REFERENCES:	1. Engineering Drawing And Graphics + Autocad, Venugopal K, New Age International Pvt. Ltd.New Delhi, 2007. 2. Engineering Graphics with Auto CAD, D.M. Kulkarni, A.P. Rastogi and A.K. Sarkar, PHI Learning Private Limited, Revised Edition, August 2010. 3. Engineering Drawing and Graphics Using Autocad, T Jeyapoovan, Vikas Publishing House, 3rd Edition, 2010. 4. A Textbook on Engineering Drawing, P. Kannaiah, K. L. Narayana, K. Venkata Reddy, Radiant Publishing House, 2012.

20SH11P3-ENGINEERING CHEMISTRY LABORATORY

(Common for ME and CE)

Course Category:	Basic science	**Credits:**	1.5
Course Type:	Practical	**Lecture-Tutorial-Practical:**	0-0-3
Pre-requisite:	Fundamental concepts of Chemistry	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives	The main objective is to provide students to learn about experimental techniques in chemistry with knowledge in theoretical aspects so that they can excel in that particular field.		
Course Outcomes	Upon successful completion of the course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Determine the cell constant and conductance of solutions	K5
	CO2	Prepare advanced polymer materials	K6
Course Content	Minimum of 8 experiments to be completed out of the following: **LIST OF EXPERIMENTS** 1. Determination of total hardness of water by EDTA method 2. Determination of total alkalinity of water 3. Estimation of Dissolved oxygen by Winkler's method 4. Estimation of chlorides using potassium chromate indicator 5. Determination of cell constant and conductance of solutions 6. Conductometric titration of strong acid Vs strong base 7. Conductometric titration of weak acid Vs strong base 8. Determination of pH of unknown solution 9. Potentiometry - determination of redox potentials and emfs 10. Determination of Strength of an acid in Pb-Acid battery 11. Preparation of a polymer-Bakelite 12. Determination of viscosity of oils with Redwood viscometer 1&2 13. Determination of Flash and Fire points 14. Estimation of calcium in portland cement		
TEXT BOOKS:	1. Mendham J et al, Vogel's text books of quantitative chemical analysis, 5 Ed., pearson publications, 2012. 2. KN Jayaveera, Subba Reddy & Chandra Sekhar , Chemistry lab manual, 1 Ed., SM Enterprises, Hyderabad, 2014 3. Chatwal & Anand , Instrumental methods of chemical analysis, 2 Ed., Himalaya publications, 2006.		

20CS11P1 – PROGRAMMING FOR PROBLEM SOLVING LABORATORY
(Common to All Branches)

Course Category:	Program Core	**Credits:**	3
Course type:	Practical	**Lecture- Tutorial-Practical:**	0-0-3
Prerequisite:	Basic mathematical knowledge to solve problems and computer fundamentals	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives	To learn the C programming constructs and its implementation		
Course Outcomes	Upon successful completion of the course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Solve problems using C programming concepts	K5
Course Content	1. To evaluate expressions. 2. To implement if constructs. 3. To implement Switch statement. 4. To implement all iterative statements. 5. To implement Arrays. 6. To implement operations on Strings without using Library functions 7. To implement arithmetic operations using pointers. 8. Implement both recursive and non-recursive functions. 9. To implement parameter passing techniques. 10. To implement Structures. 11. To implement basic File operations		
TEXT BOOKS:	1. Programming with ANSI & TURBO C by Ashok N.Kamthane, Pearson Education 2007		
REFERENCES:	1. A Book on C by Al Kelley/Ira Pohl, Fourth Edition, Addison-Wesley.1999 2. Let Us C by Yashavant Kanetkar, BPB Publications. 3. Programming in ANSI C by Balaguruswamy 6th Edition, Tata McGraw Hill Education, 2012.		
E -Resources:	1. **https://nptel.ac.in/courses** 2. **https://freevideolectures.com/university/iitm**		

NBKR INSTITUTE OF SCIENCE & TECHNOLOGY: VIDYANAGAR (AUTONOMOUS)

(AFFILIATED TO JNTUA ANANTAPURAMU)

I YEAR OF FOUR YEAR B.TECH DEGREE COURSE – II SEMISTER

MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION AND EVALUATION

(With effect from the academic year 2020-2021)

S. No	Course Code	Course Title	Instruction Hours/Week			Credits	Evaluation							
							Sessional Test-I		Sessional Test-II		Total Sessional Marks (Max. 40)	End Semester Examination		Maximum Total Marks
		THEORY	L	T	D/P		Duration In Hours	Max. Marks	Duration In Hours	Max. Marks		Duration In Hours	Max. Marks	100
1	20SH1201	Engineering Physics	3	-	-	3	2	40	2	40	0.8*Best of two+0.2*least of two	3	60	100
2	20SH1204	Engineering Mathematics-II	3	-	-	3	2	40	2	40		3	60	100
3	20ME1201	Engineering Mechanics	2	1	-	3	2	40	2	40		3	60	100
4	20ME1202	Engineering Materials	3	-	-	3	2	40	2	40		3	60	100
5	20EE1202	Basic Electrical and Electronics Engineering	3	-	-	3	2	40	2	40		3	60	100
6	20MC1201	Universal Human Values	2	-	-	0	2	40	2	40		3	60	100
		Practicals												
7	20SH12P2	Physics Laboratory	-	-	3	1.5	3	40	3	40	Day to Day Evaluation and a test (40 Marks)	3	60	100
8	20ME12P2	Engineering Workshop	-	-	2	1.5	3	40	3	40		3	60	100
9	20CS12P3	C Programming Laboratory	-	-	3	1.5	3	40	3	40		3	60	100
		Total	**14**	**1**	**8**	**19.5**	-	-	-	**360**		-	**540**	**900**

20SH1201-ENGINEERING PHYSICS

(Common for ME and CE)

Course Category:	Basic Science	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practical:**	3-0-0
Pre-requisite:	Fundamental concepts of Physics	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

<table>
<tr><td>Course Objectives</td><td colspan="3">Students undergoing this course are expected to
1. To acquire knowledge of interference, diffraction and polarization of light.
2. Analyze principles of lasers and optical fibers applied in engineering field.
3. Apply principles of quantum mechanics to various atomic phenomena.
4. Explain & provide the knowledge about semiconductors and their use in electronic devices.
5. To gain knowledge about dielectrics & magnetic materials focusing on their applications.
6. To understand importance and role of ultrasonics and nanomaterials in Civil & Mechanical engineering</td></tr>
<tr><td rowspan="8">Course Outcomes</td><td colspan="3">Upon successful completion of the course, the student will be able to:</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>Understand the phenomena of wave optics and its principles</td><td>K2</td></tr>
<tr><td>CO2</td><td>Analyse different kinds of lasers and principles of optical fibers.</td><td>K4</td></tr>
<tr><td>CO3</td><td>Understand the basic concepts of quantum physics applicable to solids.</td><td>K2</td></tr>
<tr><td>CO4</td><td>To know the concepts of electron theory of solids and properties of semiconductor materials by projecting the view of energy bands.</td><td>K1</td></tr>
<tr><td>CO5</td><td>Understand the concept of polarization & magnetization and also applications of dielectric & magnetic materials in various disciplines.</td><td>K2</td></tr>
<tr><td>CO6</td><td>Basic idea about ultrasonics production & properties and nano materials with their uses in various fields of Science & Technology.</td><td>K1</td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT-I
Wave optics:
Interference: Introduction – Superposition of waves – interference by division of wave front (Young’s double slit experiment) & by division of amplitude (Newton rings) – Diffraction: Introduction - Fraunhoffer diffraction due to single slit, double slit– Diffraction grating – Polarization – Introduction – Representation of light – Double refraction</td></tr>
</table>

	and positive & negative crystals – Nicol prism – Half and quarter wave plates. **UNIT-II** **Lasers & Optical fibers:** **Lasers:** Spontaneous & simulated emission - Population inversion - Types of Lasers: Solid state lasers (Nd-YAG), Gas lasers (He–Ne) – Properties of laser beam: monochromacity, coherence, directionality & brightness – Applications of lasers in science, engineering & medicine. **Optical fibers:** Introduction – Construction and working principle of optical fiber – Acceptance angle & Numerical aperture – Types of optical fibers – Block diagram of optical fiber communication system – Applications of optical fibers. **UNIT-III** **Principles of Quantum Mechanics:** Black body radiation – Laws of explaining the energy distribution-Planks quantum theory of black body radiation – Stefan-Boltzmann, Wein's displacement & Rayleigh Jean's law - Photon & its properties - Wave and particle duality – de-Broglie hypothesis – Properties of matter waves – de-Broglie wave length – Heisenberg uncertainty principle – Schrodinger time independent wave equation – Physical significance of wave function - Particle in one dimensional potential box. **UNIT-IV** **Electron theory and Semiconductors:** **Electron theory**: Free electron theory (classical & quantum: postulates, success& drawbacks) - Fermi–Dirac distribution function & its temperature dependence – Kronig–Penny model (non mathematical treatment) – Concept of band – Classification of solids into conductors , semiconductors & insulators. **Semiconductors**: Intrinsic & extrinsic semiconductors (qualitative) – Fermi level in extrinsic semiconductors – Conductivity in semiconductors : Drift & diffusion – Einstein relation – Hall effect & its applications. **UNIT-V** **Dielectric and Magnetic Properties:** **Dielectric Properties:** Basic definitions – Electronic, ionic & orientation polarizations (qualitative) – Internal field in solid dielectrics – Clausius- Mossotti relation – Ferroelectricity – Applications of dielectrics. **Magnetic properties:** Introduction – Basic definitions (B, M, H & χ) – Origin of magnetic moment – Classification into dia, para, ferro, anti ferro & ferri magnetic materials – Hysteresis – Soft & hard magnetic materials - Applications of magnetic materials.

	UNIT VI **Ultrasonics and Physics of Nanomaterials:** **Ultrasonics:** Introduction and properties of ultrasonics – Production by Piezo electric method – Detection of ultrasonics – Applications of ultrasonics. **Physics of Nanomaterials:** Introduction – Significance of nanoscale – Types of nanomaterials – Properties of nanomaterials: physical, mechanical, magnetic and optical – Synthesis of nanomaterials: top-down-Ball milling, bottom up – Chemical vapour deposition – Applications of nanomaterials.
TEXT BOOKS:	1. Engineering Physics by P.K.Palanisamy, Scitech Publications (2nd edition). 2. Engineering Physics by S.Maninaidu, Pearson (2009). 3. Applied Physics by K.Thyagarajan, McGraw Hill (2019).
REFERENCES:	1. 1.Solid State Physics, by C.Kittel, Wiley India PVT Limited (2007) 2. Solid State Physics by S.O.Pillai, New Age International Publishers (2018). 3. Engineering Physics by R.K.Gaur and S.L.Gupta, Dhanpatrai Publications(2012)

20SH1204-ENGINEERING MATHEMATICS – II

(Common to All Branches)

<table>
<tr><td>Course Category:</td><td>Basic Sciences</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture-Tutorial-Practical:</td><td>3-0-0</td></tr>
<tr><td>Pre – requisite:</td><td>Intermediate Mathematics</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">To make the student learn about
1. The concepts of Double integrals, Areas and Volumes
2. The basic concepts of Triple integrals and its volume, Beta and Gamma functions.
3. The Gradient, Divergence and Curl operators, Solenoidal and Irrotational vectors.
4. The basic concepts of Vector Integration.
5. The determination of Fourier coefficients, Fourier series, Even and Odd Functions and Change of intervals.
6. The concepts of Fourier Transforms.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">After completing the course the student will be able to
<table><tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr><tr><td>CO1</td><td>Analyze the Double integrals also its Areas and Volumes.</td><td>K4</td></tr><tr><td>CO2</td><td>Understand effectively in analyzing the Triple integrals, Beta and Gamma functions</td><td>K2</td></tr><tr><td>CO3</td><td>Acquire knowledge in analyzing the Curl, Divergence and Gradient operators, Solenoidal and Irrotational vectors with their applications.</td><td>K3</td></tr><tr><td>CO4</td><td>Aanalyze the applications of Green’s, Stoke’s and Gauss-divergence theorems.</td><td>K4</td></tr><tr><td>CO5</td><td>Develop analytical skills in solving the problems involving Fourier Series.</td><td>K3</td></tr><tr><td>CO6</td><td>Understand effectively Fourier Sine and Cosine integral, Fourier Transforms, Fourier Sine and Cosine transforms.</td><td>K2</td></tr></table></td></tr>
<tr><td></td><td colspan="3">UNIT – I

Double integrals: Double integrals - Change of order of integration - Change to polar coordinates - Area and Volumes by double integration.</td></tr>
</table>

Course Content	**UNIT - II** **Tripple integrals and Special functions:** Evaluation of triple integrals, Volume by triple integral. Beta and Gamma functions and their properties, Relation between Beta and Gamma functions. **UNIT – III** **Vector Differentiation:** Scalar and vector point function, Vector operator Del, Del applied to scalar point function, Gradient, Divergence, Curl, Solenoidal and Irrotational vectors. **UNIT – IV** **Vector Integration:** Line integral-circulation-workdone, Surface integrals – flux, Green's theorem in the plain (Without proof), Stoke's theorem (Without proof), Volume integral, Gauss-divergence theorem (without proof). **UNIT-V** **Fourier Series:** Determination of Fourier coefficients - Fourier series - Even and Odd functions - Change of intervals (0,2l). **UNIT-VI** **Fourier Transforms:** Fourier Integral Theorem (Without proof)- Fourier Sine and Cosine integral - Fourier integral in complex form - Fourier Transforms - Fourier Sine and Cosine transforms.
TEXTBOOKS:	1. Higher Engineering Mathematics - B.S.Grewal, Khanna Publishers, New Delhi. 2. Engineering Mathematics - B.V. Ramana, Tata McGraw-Hill Education Pvt. Ltd, New Delhi.
REFERENCE:	1. Higher Engineering Mathematics - H.K. Dass, Er. Rajnish Verma, S.Chand Publication, New Delhi. 2. Advanced Engineering Mathematics - N.P. Bali & M. Goyal, Lakshmi Publishers, New Delhi. 3. Advanced Engineering Mathematics - Erwin Kreyszig, Wiley, India

20ME1201-ENGINEERING MECHANICS

(MECHANICAL ENGINEERING)

<table>
<tr><td>Course Category:</td><td>Programme core</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course type:</td><td>Theory</td><td>Lecture- Tutorial-Practical:</td><td>2-1-0</td></tr>
<tr><td>Prerequisite:</td><td>Basic Physics and Mathematics</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Students are made to learn
❖ The laws of mechanics, concept of forces and moments.
❖ The conditions of equilibrium of a body and procedure for drawing free body diagrams.
❖ The usages of trusses in carrying load and apply procedures for their analysis.
❖ The laws of friction, the action of friction on bodies moving on horizontal as well as inclined planes.
❖ The basic idea of centre of gravity and moment of inertia and compute the same for plane figures and solids.
❖ The importance of moment of inertia and the methods of calculating area moment of inertia of plane figures and mass moment of inertia of solids.
❖ Understand and apply Work-Energy, Impulse-momentum, Virtual work principle to simple problems.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">After completing the course the student will be able to
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Understand the concepts of basic engineering mechanics for static structures</td><td>K2</td></tr>
<tr><td>CO2</td><td>Analyze the problems on trusses using required skills or knowledge in equilibrium of forces and demonstrate the use of laws of friction.</td><td>K4</td></tr>
<tr><td>CO3</td><td>Understand the meaning of centers of gravity (mass)/centroids and determine the same for different sections.</td><td>K2</td></tr>
<tr><td>CO4</td><td>Determine the area and mass moment of inertia for different sections.</td><td>K4</td></tr>
<tr><td>CO5</td><td>Solve problems using principles, and theories in different motions of kinematics.</td><td>K4</td></tr>
<tr><td>CO6</td><td>Demonstrate work energy principle, impulse-momentum principle, Virtual work principle for simple cases.</td><td>K2</td></tr>
</table></td></tr>
<tr><td></td><td colspan="3">UNIT – I
INTRODUCTION TO ENGINEERING MECHANICS: Introduction, Resultant of forces, Resolution of forces, Law of transmissibility, Parallelogram law, Triangle and polygon law of forces; System of forces, Varignon’s principle, Moment of a force, Couple and equivalent system.</td></tr>
</table>

Course Content	**EQUILIBRIUM OF COPLANAR FORCE SYSTEM**: Principle of Equilibrium – concurrent and non-concurrent force systems, Lami's Theorem, Concept of free body diagram. **UNIT – II** **PLANE TRUSSES**: Perfect truss- mathematical condition and assumptions, Cantilever trusses and simply supported trusses – Analysis of trusses using method of joints and method of sections for vertical loads, horizontal loads **FRICTION:** Types of friction-Static and Dynamic Frictions, laws of Friction, Limiting friction, Cone of limiting friction, angle of repose, Motion of bodies on inclined planes – Ladder friction. Simple screw Jack. **UNIT – III** **CENTER OF GRAVITY:** Centroid of simple plane figures - Method of moments & Integration method, Centroid of Composite figures. Centre of Gravity of bodies - Integration method, Centre of Gravity of Composite bodies. **UNIT – IV** **MOMENT OF INERTIA:** Area moment of Inertia, Radius of gyration, Parallel axis and perpendicular axis theorems, Moment of Inertia of some standard geometrical shapes. Moment of inertia of composite areas. **MASS MOMENT OF INERTIA:** Definition, mass moment of inertia of rectangular and circular plate, cylinder, cone and sphere. **UNIT – V** **KINEMATICS OF LINEAR MOTION**: Equations of motions for linear movement with uniform velocity, uniform acceleration, variable acceleration and under gravity. Motion Curves – graphical representation only. **KINEMATICS OF CIRCULAR MOTION, ROTATION AND TRANSLATION:** Equations of motion along a circular path, Flywheel problems. Types of rigid body motion – Velocity and acceleration for combined motion of translation and rotation, Instantaneous center concept. **UNIT – VI** **KINETICS OF RIGID BODIES:** Analysis of two bodies connected by string over pulley, one body resting on horizontal plane with and without friction. D'Alembert's Principle - application to linear motion. Principle of Impulse and momentum, problems on direct central impact. Work energy equation, motion of connected bodies. Principle of virtual work and its application to beam problems.

TEXT BOOKS:	1. A text book of Engineering Mechanics – D. R.K. Bansal, Laxmi publications (P) Limited,2016 2. Engineering Mechanics: Statics and Dynamics – N.H Dubey, Tata Mc Graw Hill, New Delhi,2016
REFERENCES:	1. Engineering Mechanics – S. Timoshenko, D.H. Young – Mc Graw Hill International Edition,2013 2. Engineering Mechanics – Statics and Dynamics – Irving H Shames, G Krishna Mohana Rao – Pearson Education,2006 3. Engineering Mechanics: Statics and Dynamics – A. Nelson Dubey, Tata Mc Graw Hill, New Delhi. 4. Engineering Mechanics – Statics and Dynamics – F.L.Singer- 5. www.myengineeringmechanics.com – video lectures

20ME1202-ENGINEERING MATERIALS
(MECHANICAL ENGINEERING)

Course Category:	Programme core	**Credits:**	3
Course type:	Theory	**Lecture-Tutorial-Practical:**	3-0-0
Prerequisite:	Basic knowledge in Physics & chemistry.	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

Students undergoing this course are expected to understand:

- ❖ Classification of engineering materials and their properties.
- ❖ The basic composition, properties and applications of ferrous and non-ferrous materials.
- ❖ The structure of polymers and mechanism of polymerization.
- ❖ The ceramic and advanced materials.

Course Outcomes

At the end of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Identify the properties desired by different engineering materials in general.	K3
CO2	Identify the popular ferrous metals suitable for engineering applications and improve their properties by alloying.	K3
CO3	Identify the popular non-ferrous metals suitable for engineering applications and improve their properties by alloying	K3
CO4	Differentiate between thermoplastic and thermosetting plastics.	K4
CO5	Identify the specific applications of ceramics and refractories.	K3
CO6	Identify the need of advanced materials for growing engineering applications.	K3

Course Content

UNIT – I

Classification and Properties of Materials:

Classification of engineering materials, the property spectrum, chemical properties, properties-mechanical properties, dielectric and magnetic properties, optical and thermal properties, electrical properties.

UNIT – II

Ferrous Materials:

Plain carbon steels – classification and designation of steels, properties and applications of steels. Alloy steels – effect of alloying elements, functions and uses. Selection of alloy steels, high strength low alloy steels. Stainless steels – physical properties, mechanical properties, corrosion characteristics. Cast Irons – White cast iron, grey cast iron, ductile iron, malleable cast iron – properties and applications

	UNIT – III **Non – Ferrous Materials:** Copper and its alloys – properties & applications – brasses, bronzes, copper nickel alloys. Aluminium and its alloys – properties and applications – corrosion Classification of alloys and applications-Nickel, zinc, titanium, magnesium **UNIT – IV** **Plastics and Polymers** Structure of polymers, classification of polymers, chain formation by addition mechanism, chain formation by condensation mechanism, degree of polymerisation. Thermoplastics – Structure and properties, applications. Thermosetting polymers. **UNIT –V** **Ceramic Materials:** Properties & applications of clay, cement & Concrete, glasses, refractories, asphalt. Advanced ceramic materials – alumina, boron carbide, silicon carbide, sialon, zirconia. Electrical and magnetic properties of ceramics. **UNIT –VI** **Advanced Materials:** Nanomaterials – nano particles, polymer nanocomposites – dispersion reinforced composites, plastic reinforced composites, laminated composites, fibre reinforced composites. Semiconductors, smart materials and shaper memory alloys.
TEXT BOOKS:	1. Kenneth .G. Budinski & Michael . K. Budinski, - Engineering Materials Properties and Selection, PHI learning Private Ltd Publishers. 19 th edition. 2. B.K.Agrawal,-Introduction to Engineering Materials, Mc Graw Hill Education(India) Private Limited, New Delhi. 3. Donald.R.Askeland,- The Science and Engineering of Materials, Chapman and Hall Publishers, Second S.I.Edition.
REFERENCES:	1. Dr C. Daniel Yesudian & Dr. D.G. Harris Samuel- Material Science and Metallurgy, Scitech Publications(India) Pvt Ltd, Chennai 2. V.Rajendran & A.Marikani- Material Science, Tata Mc-Graw Hill Publishing Company limited, New Delhi.

20EE1202 - BASIC ELECTRICAL & ELECTRONICS ENGINEERING
(MECHANICAL ENGINEERING)

Course Category:	Engineering Science	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practical:**	3-0-0
Pre-requisite:	Basic sciences	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

To make the student learn about

1. The basic concepts of DC circuits.
2. The basic concepts of AC circuits
3. The concepts of Resonance.
4. The properties of semi-conductor diode.
5. The concepts of Rectifiers and Filters.
6. The characteristics of BJT.

Course Outcomes

After completing the course the student will be able to

CO	Course Outcomes	Knowledge Level
CO1	Comprehend the basic concepts of D.C circuits	K2
CO2	Analyse the fundamental concepts of single phase A.C circuits.	K4
CO3	Understand the concepts of Resonance.	K2
CO4	Understand the basic properties of semi-conductor diode.	K2
CO5	Understand the basic concepts of Rectifiers and Filters.	K2
CO6	Understand the characteristics of BJT.	K2

Course Content

UNIT-I

Fundamentals of DC Circuits: Introduction to DC circuits, Active and passive elements, Ohms law, Voltage-Current relations for resistor, inductor, capacitor, Kirchhoff's laws, Mesh and Nodal analysis with independent sources.

UNIT-II

Fundamentals of AC Circuits: Generation of sinusoidal voltage, Average and RMS values, Form Factor and peak factors for sinusoidal waveforms, Analysis of R, L, C circuits with sinusoidal source, j notation, Concept of Impedance.

UNIT-III

Resonance: Series and parallel resonance, Half power frequencies, Bandwidth and Quality factor, Relation between half power frequencies-Problems

	UNIT-IV **Junction Diode:** Band Structure of P-N junction diode, Current Components, Volt-Ampere Characteristics and its temperature dependence, Diode resistance and capacitance, Zener diode and tunnel diode **UNIT-V** **Rectifiers:** Diode equivalent circuit, Half-Wave and Full-Wave (Centred tapped & Bridge) rectifiers, Analysis of filters with full-wave rectifier. **UNIT-VI** **Bipolar Junction Transistor:** Transistor action, PNP and NPN Transistors, CB,CE,CC Configurations and their characteristics, analytical expressions for transistor characteristics, specifications of BJT, Determination of h-parameters from BJT characteristics.
TEXT BOOKS:	1. A.Sudhakar and Shyam Mohan, "Circuits & Networks", 5th Edition(2015),TMH 2. A.Chakrabarti, "Circuit Theory", Dhanpat Rai publishers 6th Edition 2014. 3. R.L.Boylestad, Louis Nashelsky, "Electronic devices and circuits", 9th ed.,2008 PE.
REFERENCES:	1. M.E Van Valkenburg, "Network Analysis", Third Edition, PHI learning private Limited, 2006. 2. Allen Mottershed, "Electronic devices and circuits", Prentice Hall of India. 3. Millman and Halkias, "Integrated Electronics", MC Graw Hill & Co.
E-Resources:	http://nptel.ac.in/courses http://iete-elan.ac.in http://freevideolectures.com/university/iitm

20MC1201 UNIVERSAL HUMAN VALUES

(Common to All Branches)

<table>
<tr><td>Course Category:</td><td>Mandatory Course</td><td>Credits:</td><td>0</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture -Tutorial-Practical:</td><td>2-0-0</td></tr>
<tr><td>Pre – requisite:</td><td>SIP-Universal Human Values 1 (Desirable)</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Students undergoing this course are expected:

1. Development of a holistic perspective based on self-exploration about human being, family, society and nature/existence.
2. Developing clear understanding of the harmony in the human being, family, society and nature/existence.
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.
5. Know about appropriate management patterns with harmony.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">After completing the course, the student will be able to

<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Understand more about of themselves, and their surroundings (family, society, nature);</td><td>K2</td></tr>
<tr><td>CO2</td><td>Become more responsible in life, and in handling problems with sustainable solutions, while keeping human relationships and human nature in mind.</td><td>K3</td></tr>
<tr><td>CO3</td><td>Develop as a socially and ecologically responsible engineers</td><td>K3</td></tr>
<tr><td>CO4</td><td>Justify the need for universal human values and harmonious existence</td><td>K4</td></tr>
<tr><td>CO5</td><td>Relate human values with human relationship and human society</td><td>K2</td></tr>
<tr><td>CO6</td><td>Apply what they have learnt to their own self in different day-to-day settings in real life, at least a beginning would be made in this direction.</td><td>K3</td></tr>
</table></td></tr>
<tr><td></td><td colspan="3">UNIT-I

Introduction to Value Education:

Universal Human Values- I - Self-Exploration - content and process; ‘Natural Acceptance’ and Experiential Validation - Self-exploration - Continuous Happiness and Prosperity - Basic Human Aspirations - Current scenario - Method to fulfill the above human aspirations- Understanding and living in harmony at various levels.</td></tr>
</table>

Course Content	**UNIT-II** **Understanding Harmony in the Human Being - Harmony in Myself:** Human being as a co-existence of the sentient 'I' and the material 'Body' - The needs, happiness and physical facility - The Body as an instrument of 'I' - The characteristics and activities of 'I' and harmony in 'I' - The harmony of I with the Body **UNIT-III** **Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship:** Values in human relationship; meaning of Justice; Trust and Respect; Difference between intention and competence; the other salient values in relationship - the harmony in the society: Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals - Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family. **UNIT-IV** **Understanding Harmony in the Nature and Existence - Whole existence as Coexistence:** The harmony in the Nature - Interconnectedness and mutual fulfillment among the four orders of nature- Recyclability and self-regulation in nature - Understanding Existence as Co-existence of mutually interacting units in all-pervasive space - Holistic perception of harmony at all levels of existence. **UNIT-V** **Implications of the above Holistic Understanding of Harmony on Professional Ethics:** Natural acceptance of human values - Definitiveness of Ethical Human Conduct - Basic for Humanistic Education - Humanistic Constitution and Humanistic Universal Order - Competence in professional ethics: Professional competence – People-friendly and eco-friendly production systems - Appropriate technologies and management patterns for above production systems. **UNIT-VI** **Case studies and Strategy:** Case studies of typical holistic technologies, management models and production systems - Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations.
TEXTBOOKS:	1. A Foundation Course in Human Values and Professional

	Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-47-1
REFERENCES:	1. Teachers' Manual for A Foundation Course in Human Values and Professional Ethics, R R Gaur, R Asthana, G P Bagaria, 2nd Revised Edition, Excel Books, New Delhi, 2019. ISBN 978-93-87034-53-2 2. JeevanVidya: Ek. Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999. 3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004. 4. The Story of Stuff (Book). 5. The Story of My Experiments with Truth - by Mohandas Karam chand Gandhi 6. Small is Beautiful - E. F Schumacher. 7. Slow is Beautiful - Cecile Andrews 8. Economy of Permanence - J C Kumarappa 9. Bharat Mein Angreji Raj - PanditSunderlal 10. Rediscovering India - by Dharampal 11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi 12. India Wins Freedom - Maulana Abdul Kalam Azad 13. Vivekananda - Romain Rolland (English) 14. Gandhi - Romain Rolland (English)
E-Resources:	1. https://www.youtube.com/channel/UCo8MpJB_aaVwB4LWLAx6AhQ 2. https://aktu.ac.in/hvpe 3. http://www.storyofstuff.com 4. https://fdp-si.aicte-india.org/download.php#1

20SH12P2-ENGINEERING PHYSICS LABORATORY

(Common to ME&CE)

Course Category:	Basic Science	**Credits:**	1.5
Course Type:	Practical	**Lecture-Tutorial-Practical:**	0-0-3
Pre-requisite:	Fundamental concepts of Physics	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives	To provide student to learn about some important experimental techniques in physics with knowledge in theoretical aspects so that they can excel in that particular field.		
Course Outcomes	After completing the course, the student will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Apply theoretical knowledge	K3
	CO2	Develop skills to recognize where the ideas of the students agree with those accepted by physics and where they do not.	K5
Course Content	**Minimum of 8 experiments to be conducted out of the following** **LIST OF EXPERIMENTS** 1. Determination of rigidity modulus of wire material – Torsional pendulum. 2. Melde's experiment – Transverse & longitudinal modes. 3. Resonance in LCR circuit. 4. Magnetic field along the axis of a coil (Stewart – Gee's Method). 5. Study of characteristics of LED 6. Newton rings 7. Wedge method 8. Diffraction grating - Wavelength of given source. 9. Dispersive power of prism material using spectrometer. 10. P-N- junction diode characteristics. 11. Evaluation of Numerical Aperture of given optical fiber. 12. Energy gap of a P-N junction diode material. 13. Transistor characteristics. 14. Solarcell characteristics. 15. Logic gates.		

20ME12P2- ENGINEERING WORKSHOP

(Common to ME & CE)

Course Category:	Engineering Science	**Credits:**	1.5
Course type:	Practical	**Lecture- Tutorial-Practical:**	0-0-3
Prerequisite:	No Prerequisite	**Sessional Evaluation:**	40
		External Exam Evaluation:	60
		Total Marks:	100
		External Exam Duration:	3 hrs

Course Objectives	1. To understand the usage of work shop tools and prepare the models in the trades such as carpentry, fitting, sheet metal & foundry. 2. To understand the usage of wiring tools and to execute house wiring connections. 3. To understand and demonstrate the usage of tools of welding, black smithy and machine tools.		
Course Outcomes	After completing the course the student will be able to:		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Identify, Distinguish and Choose the tools of various trades (carpentry, fitting, sheet metal, foundry, wiring, welding, black smithy and machine tools).	K3
	CO2	Demonstrate and Describe the usage of tools of various trades (carpentry, fitting, sheet metal, foundry, wiring, welding, black smithy and machine tools).	K2
	CO3	Documenting the procedure adopted while preparing the model.	K6
Course Content	1. **Carpentry**: Half Lap, Mortise and Tenon and Bridle joint. 2. **Fitting:** Square, V, half round and dovetail fittings 3. **Tin-Smithy:** Tray, cylinder, hopper, cone 4. **House-wiring:** One lamp controlled by one switch, Two lamps (bulbs) controlled by two switches independently, Stair - case connection, Two lamps controlled by one switch in series, Two lamps controlled by on switch in parallel and Water pump connected with single phase starter. 5. **Foundry**: single-piece pattern and Two- piece pattern **TRADES FOR DEMONSTRATION:** 6. Machine Tools 7. Welding 8. Black Smithy		
Text Books:	1. Engineering Work shop practice for JNTU, V. Ramesh Babu, VRB Publishers Pvt. Ltd,2009 2. Work shop Manual / P.Kannaiah/ K.L.Narayana/ SciTech Publishers,2004 3. Engineering Practices Lab Manual, Jeyapoovan, SaravanaPandian, Vikas publishers,2007.		

20CS12P3 – C PROGRAMMING LABORATORY

(MECHANICAL ENGINEERING)

Course Category:	Program Core	**Credits:**	1.5
Course Type:	Practical	**Lecture – Tutorial – Practical:**	0-0-3
Prerequisite:	Knowledge on computer fundamentals and basic Mathematics	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives	To learn the C programming constructs and its implementation		
Course Outcomes	Upon successful completion of the course, the students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Solve problems using C programming concepts	K5
Course Content	1. Familiarization with computer hardware and programming environment, concept of naming the program files, storing, compilation, execution and debugging. Taking any simple C-code. (a) Develop a Program to read length and breadth of a rectangle and find out area and perimeter. (b) Develop a Program to read 3 sides of a triangle and find out area of a triangle. (c) Develop a Program to read principle amount, rate of interest, time. Find out Compound Interest. 2. An electricity board charges the following rates for the use of electricity: for the first 200 units 80 paise per unit: for the next 100 units 90 paise per unit: beyond 300 units Rs 1 per unit. All users are charged a minimum of Rs. 100 as meter charge. If the total amount is more than Rs 400, then an additional surcharge of 15% of total amount is charged. Write a program to read the name of the user, number of units consumed and print out the charges. 3. Write a C program that uses functions to perform the following operations: i) Reading a complex number ii) Writing a complex number iii) Addition of two complex numbers iv) Multiplication of two complex numbers 4. Implement using functions to check whether the given number is prime and display appropriate messages. (No built-in math function) 5. Develop a Program to compute Sin(x) using Taylor series approximation. Compare your result with the built- in Library		

	function. Print both the results with appropriate messages. 6. Implement structures to read, write, compute average- marks and the students scoring above and below the average marks for a class of N students. 7. Implement Recursive functions for Binary to Decimal Conversion 8. The total distance traveled by vehicle in't' seconds is given by distance = ut+1/2at2 where 'u' and 'a' are the initial velocity (m/sec.) and acceleration (m/sec2). Write C program to find the distance traveled at regular intervals of time given the values of 'u' and 'a'. The program should provide the flexibility to the user to select his own time intervals and repeat the calculations for different values of 'u' and 'a'. 9. Write a C- Program that Uses Functions to insert a Sub-String in to a Given Main String from a Given Position. 10. Write a C -program to construct a pyramid of numbers. 11. Write a C- program to read in two numbers, x and n, and then compute the sum of this geometric progression: 1+x+x2+x3+x4+…….+xn Print x, n, the sum Perform error checking. For example, the formula does not make sense for negative exponents- if n is less than 0. Have your program print an error message if n<0 then go back and read in the next pair of numbers of without computing the sum. Are any values of x also illegal ? If so, test for them too. 12. Write a C- program for finding the 2's complement of a binary number 13. Write a C program to convert a Roman numeral to its decimal equivalent. 14. Write a C program which copies one file to another. 15. Develop a program using pointers to compute the sum, mean and standard deviation of all elements stored in an array of n real numbers.
TEXT BOOK(S):	1. Programming with ANSI & TURBO C by Ashok N.Kamthane, Pearson Education 2007
REFERENCES:	1. A Book on C by Al Kelley/Ira Pohl, Fourth Edition, Addison-Wesley.1999 2. Let Us C by YashvantKanetkar, BPB Publications. 3. Programming in ANSI C by Balaguruswamy 6th Edition, Tata McGraw Hill Education, 2012.
E-Resources:	1. https://nptel.ac.in/courses 2. https://freevideolectures.com/university/iitm

N.B.K.R. INSTITUTE OF SCIENCE & TECHNOLOGY

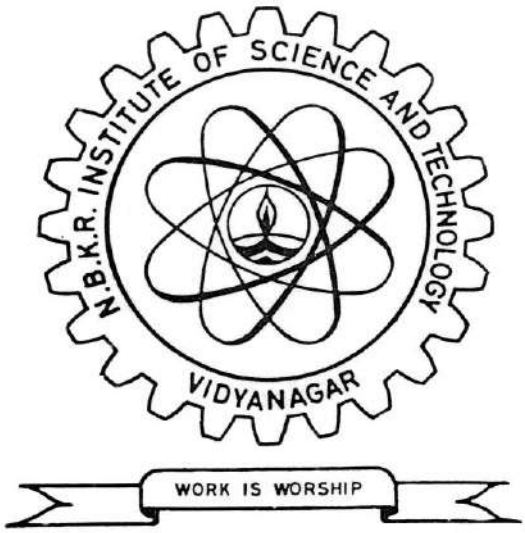
(AUTONOMOUS)

COLLEGE WITH POTENTIAL FOR EXCELLENCE (CPE)

Affiliated to JNTUA, Ananthapuramu

Re-Accredited by NAAC with 'A' Grade

B.Tech. Courses Accredited by NBA under TIER-I



SYLLABUS

B.TECH. DEGREE COURSE

II B.TECH

I & II Semesters

MECHANICAL ENGINEERING

(With effect from the batch admitted in the academic year 2020-2021)

VIDYANAGAR - 524413

SPSR Nellore-Dist. Andhra Pradesh

www.nbkrist.org

INSTITUTE VISION

To emerge as a comprehensive Institute that provides quality technical education and research thereby building up a precious human resource for the industry and society.

INSTITUTE MISSION

- To provide a learner-centered environment that challenges individuals to actively participate in the education process.

- To empower the faculty to excel in teaching while engaging in research, creativity and public service.

- To develop effective learning skills enabling students pick up critical thinking thus crafting them professionally fit and ethically strong.

- To share human and academic resources with industries, schools and public agencies through partnerships and outreach activities.

VISION OF THE DEPARTMENT

To become an excellent centre for technical education and research in the field of mechanical engineering to meet the societal, regional, national and global challenges.

MISSION OF THE DEPARTMENT

M1: To impart quality technical education and transform bud engineers into an effective and responsible engineers to work with the current technologies in multi-cultural and multi-discipline environment.

M2: To encourage the students to develop their creativity in the field of mechanical engineering by providing modern laboratory facilities with hands on training and contemporary curriculum.

M3: To develop the interaction with the Industry experts to gain practical knowledge.

M4: To provide best teaching & learning practices as well as creating opportunities for Research, maximise student results and placements.

M5: To inculcate and promote lifelong learning skills, problem solving skills, leadership qualities and team work.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: A strong foundation to access, analyze, plan and implement their knowledge in basic sciences & mathematics, core and interdisciplinary courses.

PEO 2: Graduate will be in a position to work with the members of multi-disciplinary teams and can play a leading role in handling the technical issues.

PEO 3: Graduates will have capability to work with modern engineering tools, software and equipment under the realistic constraints.

PEO 4: Graduates will engage in lifelong learning skills with research attitude and social responsibility.

PROGRAM OUTCOMES(POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review the research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO11 **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.

PO12 **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.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1 Solve engineering problems in the area of Robotics and Automation.

PSO2 Design, Simulate and Analyze using CAD/CAM/CAE tools.

NBKR INSTITUTE OF SCIENCE & TECHNOLOGY: VIDYANAGAR (AUTONOMOUS)
(AFFILIATED TO JNTUA ANANTAPURAMU)

II YEAR OF FOUR YEAR B.TECH DEGREE COURSE – I SEMESTER

MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION AND EVALUATION (With effect from the academic year 2020-2021)

S.No	Course Code	Course Title	Instruction Hours/Week			Credits	Evaluation							
							Sessional Test-I		Sessional Test-II		Total Sessional Marks (Max. 40)	End Semester Examination		Maximum Total Marks
		THEORY	L	T	D/P		Duration In Hours	Max. Marks	Duration In Hours	Max. Marks		Duration In Hours	Max. Marks	
1	20SH2101	Applied Mathematics	2	1	-	3	2	40	2	40	0.8*Best of two+0.2*least of two	3	60	100
2	20ME2101	Thermodynamics-I	2	1	-	3	2	40	2	40		3	60	100
3	20ME2102	Basic Manufacturing Processes	3	0	-	3	2	40	2	40		3	60	100
4	20ME2103	Strength of Materials	2	1	2	3	2	40	2	40		3	60	100
5	20ME2104	Materials Science & Metallurgy	3	0	1	3	2	40	2	40		3	60	100
		PRACTICALS												
6	20ME21P1	Computer Aided Machine Drawing Laboratory	-	-	3	1.5	-	-	-	40	Day to Day Evaluation and a test (40 Marks)	3	60	100
7	20ME21P2	Production Engineering Laboratory	-	-	3	1.5	-	-	-	40		3	60	100
8	20ME21P3	Materials Science & Metallurgy Laboratory	-	-	3	1.5	-	-	-	40		3	60	100
		SKILL ORIENTED COURSE 1												
9	20ME21SC	Python Programming	0	0	4	2	-	40		40		3	60	100
		TOTAL	12	03	16	21.5	-	-	-	360		-	540	900

20SH2101 APPLIED MATHEMATICS

(Mechanical Engineering)

<table>
<tr><td>Course Category:</td><td>Basic Sciences</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture -Tutorial-Practical:</td><td>2-1-0</td></tr>
<tr><td>Pre – requisite:</td><td>Intermediate Mathematics</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives:</td><td colspan="3">To make the student learn about
1. The basic concepts of numerical solutions of simultaneous linear and non-Linear algebraic equations.
2. The numerical methods to solve Ordinary Differential Equations by using Taylor’s series method, Picard’s method, Euler’s and Modified Euler’s Methods and Runge-Kutta methods of 2nd and 4th order
3. The basic concepts of Partial Differential Equations
4. The applications of Partial Differential Equations
5. The basic concepts of Sampling Distribution.
6. Type I and Type II errors and student’s t-test - F-test - Chi-square test of goodness of fit</td></tr>
<tr><td rowspan="8">Course Outcomes:</td><td colspan="3">After completing the course, the student will be able to</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>Have a sound knowledge in analyzing the simultaneous linear and non-linear algebraic equations by various numerical methods.</td><td>K4</td></tr>
<tr><td>CO2</td><td>Understand effectively the significance numerical methods to solve Ordinary Differential Equations.</td><td>K2</td></tr>
<tr><td>CO3</td><td>Acquire knowledge in solving partial differential equations by using the appropriate techniques</td><td>K3</td></tr>
<tr><td>CO4</td><td>Have a sound knowledge in analyzing One dimensional wave equation, Heat flow equation and Two dimensional Laplace equations</td><td>K4</td></tr>
<tr><td>CO5</td><td>Have a good grasp of Sampling distribution of the mean proportions, Sums and differences, Point Estimation and Interval Estimation</td><td>K2</td></tr>
<tr><td>CO6</td><td>Acquire knowledge in Type I and Type II errors - One tail and two-tail tests and also student’s t-test - F-test - Chi-square test of goodness of fit.</td><td>K3</td></tr>
</table>

Course Content:	**UNIT - I** **Solution of Simultaneous Linear and Non-linear Algebraic Equations:** Iteration method, Gauss Jordon method, Gauss Elimination with Pivotal condensation method, Triangular Factorization method, Gauss-Seidal method and Newton-Raphson method **UNIT - II** **Numerical Solution of Ordinary Differential Equations:** Solution by Taylor's Series, Picard's Method of Successive Approximations, Euler's Methods and Runge-Kutta Method of 2^{nd} order and 4^{th} order. **UNIT-III** **Partial Differential Equations and Applications**: Formation of Partial differential equations – Solution of Partial differential equations – Equations solvable by direct integration – Linear equation of the first order – Non- Linear equation of the first order – Charpit's Method **UNIT – IV** **Applications of Partial Differential Equations**: Methods of Separation of Variables - One Dimensional Wave equation - One Dimensional Heat flow equation - Two dimensional Laplace equations. **UNIT-V** **Sampling Distributions**: Population and Samples - Sampling distribution of the mean proportions, Sums and differences. Estimation: Point Estimation - Interval Estimation. **UNIT – VI** **Test of Hypothesis and Test of Significance:** Test of Hypothesis: Means - Hypothesis concerning one and two means - Type I and Type II errors - One tail, two-tail tests. Test of Significance: Student's t-test - F-test - Chi-square test of goodness of fit.
Textbooks:	1. Higher Engineering Mathematics - B.S. Grewal, Khanna Publishers, New Delhi. 2. Engineering Mathematics - B.V. Ramana, Tata McGraw-Hill Education Pvt. Ltd, New Delhi. 3. Advanced Engineering Mathematics - Erwin Kreyszig, Wiley, India 4. Probability and for engineers- G. S. S. Bhishma Rao, Scitech Publications (India) Pvt Ltd, New Delhi. 5. Probability and statistics- Dr.T.K.V. Iyengar, Dr.B.Krishna Gandhi, S.Ranganatham, Dr.M.V.S.S.N. Prasad, S. Chand Publication, New Delhi
Reference:	1. Higher Engineering Mathematics - H.K. Dass, Er. Rajnish Verma, S. Chand Publication, New Delhi. 2. Engineering Mathematics -III - Dr.T.K.V. Iyengar, Dr.B. Krishna Gandhi, S. Ranganatham, Dr.M.V.S.S.N. Prasad, S. Chand Publication, New Delhi 3. Probability & Statistics for engineers-Miller and JohnFreund ,E.Pearson Education, New Delhi.

20ME2101-THERMODYNAMICS - I

<table>
<tr><td>Course Category:</td><td>Program Core</td><td colspan="2">Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td colspan="2">Lecture – Tutorial – Practical:</td><td>2-1-0</td></tr>
<tr><td>Pre-requisite:</td><td colspan="2">Engineering Physics & Chemistry</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives:</td><td colspan="4">Students undergoing this course are expected to understand:
1. To understand the basic concepts and basic laws of thermodynamics and their applications.
2. To understand the process of steam formation and its representation on property diagrams and to calculate the quality of the steam with the help of steam tables and charts.
3. To understand the operating principles of air standard cycles, thermal power cycles, Refrigeration cycles and their performance Evaluation</td></tr>
<tr><td rowspan="8">Course Outcomes:</td><td colspan="4">Upon the successful completion of the course, the students will be able to:</td></tr>
<tr><td>CO</td><td colspan="2">Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td colspan="2">Understand and Apply basic principles of Thermodynamics.</td><td>K2</td></tr>
<tr><td>CO2</td><td colspan="2">Apply first law of Thermodynamics to solve problems.</td><td>K3</td></tr>
<tr><td>CO3</td><td colspan="2">Apply second law of Thermodynamics to solve problems.</td><td>K3</td></tr>
<tr><td>CO4</td><td colspan="2">Understand the concept of Entropy, Availability and Thermodynamic relations.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Analyze air standard power cycles</td><td>K4</td></tr>
<tr><td>CO6</td><td colspan="2">Understand and solve problems on Steam properties, Vapour power cycles.</td><td>K2</td></tr>
<tr><td>Course Content:</td><td colspan="4">UNIT-I
Basic Concepts:
Thermodynamic System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic view points, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Cycle – Reversibility ,Quasi static Process, Energy in State and in Transition, Types, Work and Heat, Point and Path function. Zeroth Law of Thermodynamics – Concept of Temperature, Equation of a state for perfect gas
UNIT-II
First law of thermodynamics
Joule’s Experiments, First law of Thermodynamics – Corollaries, PMM I.
First law applied to Non-flow systems: First law of thermodynamics for a system undergoing a cycle and for a change in state of system, internal</td></tr>
</table>

	energy and enthalpy, constant volume and constant pressure specific heats and their relation to internal energy and enthalpy of ideal gases. **First law applied to a flow systems:** Control mass and control volume, first law of thermodynamics for a control volume, steady state steady flow energy equation and application to engineering equipment. **UNIT-III** **Second law of thermodynamics:** Limitations of first law, Heat engine, refrigerator and heat pump , Kelvin Planck statement, Clausius statement, perpetual motion machine of second kind, reversible and irreversible processes, Carnot cycle and Carnot heat engine, reversed heat engine ,Carnot theorem, Clausius inequality. **UNIT-IV** **Entropy and Availability:** **Entropy**: Property of entropy, Temperature entropy plot, Principle of increase of entropy, Entropy changes in thermodynamic processes. **Availability:** Availability (Exergy), Unavailable energy (anergy), Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility, Helmholtz and Gibb's functions, **UNIT-V** **Air power Cycles**: Otto, Diesel, Dual Combustion cycles, Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – Comparison of Cycles **UNIT-VI** **Vapour Power Cycles:** **Steam Properties**: Properties of steam, Use of steam tables – PV, TS, HS diagrams; Steam processes – Constant volume, constant pressure, isothermal, adiabatic and hyperbolic processes. Problems using steam tables and Mollier chart. **Basic steam power cycles**: Carnot cycle, Rankine cycle and modified Rankine cycle.
Text Books:	1. Engineering Thermodynamic - P.K. Nag, 4th Edition, Tata McGraw Hill Education Private Limited, New Delhi. 2. A Text Book of Engineering Thermodynamics- Fourth Edition, R.K. Rajput - Lakshmi Publications. **3.** Yunus A. Cengel M. and Michael A. Boles," Thermodynamics – An Engineering Approach", 8th edition, Mc Graw Hill Education(India)PrivateLimited,2014.
References:	1. K. Ramakrishna (2011), Engineering Thermodynamics, 2nd edition, Anuradha Publishers, India 2. G.J.VanWylen& Sonntag, "Fundamentals of Classical Thermodynamics", 4th Edition, Wiley publication 2005. 3. An Introduction to Thermodynamics- Y. V. C. Rao, Revised Edition, Universities Press, Hyderabad, India.
e-Resources:	1. www.learnthermo.com/tutorials.php 2. www.khanacademy.org/science/physics/thermodynamics 3. www.courseera.org/learn/thermodynamics-intro 4. www.edx.org/course/thermodynamics-iitbombayx-me209-1x-1 5. http://nptel.ac.in/courses/112106141

20ME2102- BASIC MANUFACTURING PROCESSES

<table>
<tr><td>Course Category:</td><td>Programme Core</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture – Tutorial – Practical:</td><td>3-0-0</td></tr>
<tr><td>Prerequisite:</td><td>Basics in Engineering Physics and Engineering Workshop practice</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Objectives</td><td colspan="3">Students undergoing this course are expected to understand:
1. To examine the principles associated with basic operations of casting and interpret its advantages as well as limitations.
2. To expose the students to a variety of welding processes including their typical use in our daily life.
3. To provide a technical understanding of common mechanical working of metals to aid in appropriate process section for the material.
4. To teach the process level dependence of various sheet metal operations as well as other cold working processes.
5. To understand the characteristics of various extrusion and forging processes along with their defects.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">At the end of the course, student will be able to
<table><tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr><tr><td>CO1</td><td>Select appropriate casting process, for the given manufacturing attributes</td><td>K3</td></tr><tr><td>CO2</td><td>Design gating system for the given product to be casted</td><td>K4</td></tr><tr><td>CO3</td><td>Choose right welding process to suit the selected material</td><td>K4</td></tr><tr><td>CO4</td><td>Judge the need of advanced welding method based on the properties of material.</td><td>K4</td></tr><tr><td>CO5</td><td>Examine the suitable metal forming process to impart the desired geometry to the metal</td><td>K4</td></tr><tr><td>CO6</td><td>Assess the forces involved in the metal forming process.</td><td>K4</td></tr></table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
CASTING: Introduction-Steps involved in making a casting; Pattern– Types of patterns, Materials and their allowances; Core and Core prints.
Moulding sands-ingredients, types, properties, and its testing.
Moulding Processes: Green sand moulding, dry sand moulding, CO_2 moulding, Shell moulding.
Special Casting Processes: Centrifugal, Die and Investment casting.
UNIT – II
Gating System: Elements, types of gates, Design of Gating systems-pouring time, choke area, gating ratio.
Risers: Types, functions and its location, direction of solidification, Design-size and shape. Chills and chaplets. Casting defects.
Melting Furnaces: Crucible and cupola furnaces.</td></tr>
</table>

	UNIT – III **Welding:** Classification of welding processes, types of welds and welded joints, Heat affected zones in welding, Oxy-acetylene gas welding – principle, types of flames, welding techniques, Acetylene Gas cutting; ARC welding –principle of arc generation, power source – DCSP, DCRP, AC. Electrodes - types, functions, coatings, Manual Metal Arc welding, Submerged arc welding, Plasma arc welding, Plasma arc cutting; Resistance welding – Principle, types. **UNIT – IV** **Advanced welding Processes:** Inert Gas welding –TIG, MIG, atomic hydrogen welding; EBW, LBW, USW, Explosive welding, Forge welding, Friction welding, Induction welding, Thermit welding. Welding defects – causes and remedies. **UNIT – V** **Mechanical Working of Metals:** Hot working, Cold working, Warm working, Strain hardening. Recovery, Recrystallisation and grain growth. **Sheet Metal Working Processes:** Shearing action, Cutting process - blanking, piercing; Forming process - Bending, forming, Drawing – shallow and deep; embossing and coining, cold spinning. Explosive forming and Electro-Magnetic pulse forming. **UNIT – VI** **Rolling:** Principle, Types of Rolling mills, Forces in rolling. **Extrusion of Metals:** Hot extrusion and cold extrusion, Forward extrusion, Backward extrusion, Impact extrusion, Hydrostatic extrusion. **Wire drawing and tube drawing** **Forging Processes:** Basic forging operations, forging processes - open die and closed die forging, Types of Forging - Drop Forging, press forging, forging defects.
TEXT BOOKS:	1. Manufacturing Technology : P.N. Rao, Tata McGraw Hill, 2nd ed., 2008. 2. Manufacturing Technology : Kalpakjian, Pearson edition, 4th ed., 2002. 3. Elements of Workshop Technology, Vol. 1 :,K.Hajra Choudary, Media Promoters Publishers, 15th ed., 2012.
REFERENCES:	1. Production Technology : R.K. Jain, 2nd ed., Khanna Publishers, 2001 2. Principles of Metal Castings : Rosenthal,1st ed., Tata McGraw Hill, 1955. 3.Welding Process &Technology: R.S.Parmar, New Delhi, 4th ed., Khanna Publishers, 1997. 4. Manufacturing Technology : R.K. Rajput,1sted.,Laxmi Publications, 2007.

20ME2103-STRENGTH OF MATERIALS

Course Category:	Programme Core	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practical:**	2-1-0
Pre – requisite:	Engineering Mechanics	**Sessional Evaluation:**	40
		External Exam Evaluation:	60
		Total Marks:	100
		External Exam Duration:	3 hrs

Course Objectives

Students undergoing this course are expected tounderstand:

1. To provide the basic concepts and principles of strength of materials.
2. To give an ability to calculate stresses and deformations of objects under external loadings.
3. To give an ability to apply the knowledge of strength of materials on engineering applications and design problems.
4. Describe and derive the expressions for deflections in beams under various conditions and expression for torsion used for basic design of shafts.
5. Describe and demonstrate thoroughly the concepts of principal stresses applied to solid structural numbers and drawing Mohr's circle diagram and study of theories of failures and deflections of fixed beams.Analyze slender, long columns subjected to axial loads and having knowledge on basic design concepts for spherical shells.

Course Outcomes

After completing the course the student will be able to

CO	Course Outcomes	Knowledge Level
CO1	Analyses beam shafts under various loading conditions and draw S.F and B.M diagram.	K4
CO2	Design and analyze beams with various external loading conditions under considerations of bending and shear stresses	K4
CO3	Derive expression and determine deviation of the beam under various conditions and basic design of shafts under torsion.	K3
CO4	Design and analysis of principle stress on deformable objects and study of theory of failures and deflection of fixed beam	K4
CO5	Analyze slender, long columns subjected to axial loads and Stresses on an inclined plane under different uniaxial, biaxial conditions.	K4
CO6	Understand Various theories of failure for shafts.	K2

Course Content	**UNIT-I** **Shear Force and Bending Moments :**Beam - Types of loads, types of support, shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, U.D.L., uniformly varying loads and combination of these loads – point of contra flexure – Relation between S.F., B.M. and rate of loading at the section of the beam. **UNIT-II** **Theory of Simple Bending:** Assumptions – Derivation of bending equation – Determination of bending stresses and section modulus of rectangular, circular, triangular, I, and T-sections. **Shear Stresses**: Shear stress distribution across various cross section of the beam like rectangular, circular, triangular, I and T-sections. **UNIT -III** **Deflection of Beams**: Relation between curvature slope and deflection, Determination of slope and deflection for cantilever and simply supported beams subjected to point loads, U.D.L, uniformly varying load– Double integration, Macaulay's methods. **UNIT- IV** **Torsion of Circular Shafts:** Theory of pure torsion – Assumptions, Derivation of torsion equations, polar section modulus, Torsion rigidity, Analysis of torsional stresses, power transmitted. **Thin Cylinders:** Thin seamless cylindrical shells, longitudinal and circumferential stresses - hoop, longitudinal and volumetric strains – change in diameter and volume of thin cylinders, Thin spherical shells. **Introduction to Thick cylinders.** **UNIT -V** **Columns and Struts:** Introduction, Euler's theory of long columns for different cases - Effective length of a column – Assumptions – limitation of Euler's formula, Rankine's formula. **UNIT -VI** **Principal Stresses:** Stresses on an inclined plane under different uniaxial, biaxial conditions, principal planes and principal stresses – Mohr's circle method. **Theories of Failure**: Various theories of failure – Maximum Principal Stress Theory, Maximum Principal Strain Theory, Maximum Shear Stress Theory, Strain Energy and Shear Strain Energy Theory (Von Mises Theory).
TEXT BOOKS	1. Strength of Materials by R.K.Bansal, Lakshmi Publications House Pvt. Ltd. 2. Strength of Materials by S.Ramamrutham,DhanpatRai Publishing Company Pvt. Ltd.
REFERENCES	1. Strength of Materials by S.S.Bhavikatti, Vikas Publishing House Pvt. Ltd. 2. Mechanics of Structures Vol –I by H.J.Shah and S.B.Junnarkar, Charotar Publishing House Pvt. Ltd. 3. Strength of Materials by S.S.Rattan, Tata McGraw Hill Education Pvt. Ltd. 4. Mechanics of Materials by Pytel, Cengage Learning Pvt. Ltd. 5. Strength of Materials by R.K Rajput, S.Chand& Company Ltd.

	6. Strength of Materials by D.S Prakash Rao, Universities Press Pvt. Ltd. 7. Fundamentals of Solid Mechancis by M.L.Gambhir, PHI Learning Pvt. Ltd 8. Strength of Materials and Structures by John Case et al., Butterworth-Heinemann.

20ME2104-MATERIALS SCIENCE AND METALLURGY

Course Category:	Programme core	**Credits:**	3
Course type:	Theory	**Lecture-Tutorial-Practical**	3-0-0
Prerequisite:	Basic knowledge in Physics, chemistry and Basic manufacturing processes.	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

Students undergoing this course are expected to understand:

- Crystal structure, engineering materials, equilibrium diagrams, extractive metallurgy, heat treatment, powder metallurgy and advanced materials.
- Introduce the concept of structure property relations.
- Lay the groundwork for studies in fields such as solid-state physics, mechanical behaviour of materials, phase & phase diagram, heat treatment, failure of materials & their protection, applications of recent materials.

Course Outcomes

At the end of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Recall methodology and theories in the field of material science and metallurgy.	K1
CO2	Understand various material testing methods.	K2
CO3	Use methods to draw equilibrium diagrams.	K3
CO4	Describe extraction procedure for ferrous and non-ferrous materials.	K3
CO5	Summarize the applications of Powder metallurgy and Advanced materials.	K2
CO6	Analyse phase diagrams	K4

Course Content

UNIT – 1

Crystal structure: Space lattice and unit cells, Crystal structures of common metallic materials – BCC, FCC, HCP. Atomic packing factor, Miller indices, spacing of lattice planes, Properties of Engineering Materials.

Imperfections in solids - Crystal imperfections –point, line and surface defects. Edge and screw dislocations, Burger's vector.

Plastic deformation by slip and twinning. Critical resolved shear stress for slip. Work hardening.

UNIT – II

Testing of Engineering materials: Tensile & Compressive testing. Hardness – Brinell and Rockwell tests. Impact testing. Creep – creep test,

	creep curve, Mechanism of creep. Fatigue – fatigue stress cycles, fatigue test, S-N curve. Ductile fracture and brittle fracture - Griffith's criterion. **NDT:** Fluorescent Inspection, Radiography, Magnetic particle Inspection, Ultrasonic Inspection. **UNIT – III** **Equilibrium Diagrams:** Construction of cooling curves for a pure metal and a solid solution/alloy – Gibb's phase rule for a metal system. Construction and interpretation of binary phase diagrams -Types of phase diagrams – Eutectic, Eutectoid, Peritectic, Peritectoid. Iron - Carbon system – cooling curve of pure iron. Iron–carbide equilibrium diagram. **UNIT – IV** **Extractive Metallurgy:** **Ferrous Materials:** Production of Pig Iron in the Blast furnace. Production of steel in Bessemer, and Basic Oxygen steel making. Plain carbon steels – Uses and limitations of plain carbon steels. **Alloy steels:** Effect of alloying elements in steels. High speed tool steel, stainless steels, High nickel and High chromium steels. **Cast iron:** grey, white, malleable and SG irons. **Non-Ferrous Materials:** Introduction- Extraction of Aluminum and Copper, Properties and applications of Aluminum and copper alloys. **UNIT –V** **Heat Treatment:** Construction of TTT diagram. Heat treatment of steels – Annealing, Normalizing, Hardening, Tempering, Austempering, Mar tempering. Surface hardening of steels – Carburizing, Nitriding, Cyaniding, Flame Hardening and Induction Hardening. **UNIT –VI** **Powder Metallurgy:** Production of metal powders, basic steps in powder metallurgy, advantages limitations and applications of powder metallurgy. **Advanced materials:** Introduction and applications to super alloys, Smart materials and Nano materials
TEXT BOOKS	1. Introduction to Physical Metallurgy:Avner, 2nd ed., Tata McGraw-Hill Education, 2010 2. Materials Science and Metallurgy :Kodgire V.D. 25th ed., Everest Publishing House, 2009
REFERENCES	1. Physical Metallurgy : Raghavan V., 2nd ed., PHI, 2006 2. Principles of Engineering Metallurgy: Krishna Reddy. L., New Age International, 2007 3. Materials Science and Metallurgy : Khanna O.P. 5th ed., Dhanpat Rai and Sons, 2009 4. Composite materials : Chawla K.K. 3rd edition, Springer , New York, 2012.

20ME21SC - PYTHON PROGRAMMING

(SKILL ORIENTED COURSE)

Course Category:	Professional Core	**Credits:**	2
Course Type:	Theory	**Lecture - Tutorial - Practical:**	0-0-4
Prerequisite:	Basic mathematical knowledge to solve problems and programming.	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3hrs
Objectives	To learn the fundamentals of Python constructs. To develop various simple programs using Python. To define Python functions, exceptions and various other features. To explore features of object-oriented concepts.		

Course Outcomes	Upon successful completion of this course students will be able to:		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Learn the basic building blocks of Python.	K1
	CO2	Understand the flow of execution, exception handling mechanism and functions for application development.	K2
	CO3	Study Strings, Lists and their applications.	K1
	CO4	Acquire knowledge in the concepts of Dictionaries, Tuples, and Sets.	K3
	CO5	Comprehend the rules to construct regular expressions, and apply them to text to search for patterns and make changes.	K3
	CO6	Understand Object-oriented programming paradigm in controlling the access of data and reducing the duplication of code by employing code reusability techniques.	K2

Course Content

UNIT-I

Why Python: Thrust areas of Python, Open Source Software.

Python Basics: Identifiers, Keywords, Statements and Expressions, variables, Operators, Precedence and Associativity, Data Types, Indentation, Comments, Reading Input and Writing Output, Type Conversions, type() function and "is" operator, Dynamic and Strongly Typed Language

UNIT-II

Control Flow Statements: if and nested if, for, while, Continue, Break and Pause statements, Catching Exceptions.

Functions: Built-in Functions, Commonly Used Modules, Function Definition and Calling the

	function, The return statement and void function, scope and lifetime of variables, Default Parameters, Keyword Arguments - Variable number of arguments with *args and **kwargs, command line argument **UNIT-III** **Strings:** Creating and Storing Strings, Basic String Operations, Access characters by Index, Slicing and Joining of Strings, String Methods and Formatting Strings. **Lists:** Creating Lists, List operations, indexing and Slicing, Built-in Functions, List Methods, del() vs pop(). **UNIT-IV** **Dictionaries:** Creation, Accessing and modifying key-value pairs, Built-in functions used on dictionaries, Dictionary methods, del statement. **Tuples and Sets**: Creation of Tuples, Basic Tuple Operations, Indexing and Slicing in Tuples, Built-in functions, Relationship among Tuples, Lists and Dictionaries, Tuple Methods, aggregation with zip(), Sets, Set Methods and Frozen sets. **UNIT-V** **Files**: Types, Creating, Reading Text data and methods used for it, Manipulating Binary and CSV files, pickling (serialization of objects), os and os.path modules. **Regular Expression Operations**: Using Special Characters, Regular Expression Methods, Named Groups in Python Regular Expression and Regular Expression with glob Module. **UNIT-VI** **Object-Oriented Programming** (theory perception only)**:** Classes and Objects, The Constructor Method, Classes with Multiple Objects, Class Attributes versus Data Attributes, Encapsulation, Inheritance, Polymorphism.
TEXT BOOKS	1. Gowrishankar. S, Veena.A, "Introduction to Python Programming",CRC Press, Taylor and Francis group,2019.
REFERENCES	1. Brian Heinold, A Practical Introduction to Python Programming. 1. April Speigh, Bite-Size Python: An Introduction to Python Programming. Kenneth A. Lambert, Fundamentals of python - Data structures. 2. Mark Summerfield, Programming in python 3. 3. YaswanthKanetkar, Aditya Kanetkar, Let Us Python, BPB Publications, 2020
E-Resources	https://nptel.ac.in/courses https://freevideolectures.com/university/iitm https://wiki.python.org/moin/PythonBooks

20ME21P1-COMPUTER AIDED MACHINE DRAWING LABORATORY

<table>
<tr><td>Course Category:</td><td>Programme Core</td><td>Credits:</td><td>1.5</td></tr>
<tr><td>Course Type:</td><td>Practical</td><td>Lecture-Tutorial-Practical:</td><td>0-0-3</td></tr>
<tr><td>Pre-requisite:</td><td>Computer Aided Engineering Drawing</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Students undergoing this course are expected to understand:
1. To make the students understand and interpret drawings of machine components so as to prepare assembly drawings either manually and using standard CAD packages.
2. To familiarize the students with Indian Standards on drawing practices and standard components
3. To understand and handle design problems in a systematic manner.
4. To gain practical experience in handling 2D drafting and 3D modeling software systems.
5. To apply CAD in real life applications.
6. To enhance the employability skills that improves placement opportunities.</td></tr>
<tr><td rowspan="6">Course Outcomes</td><td colspan="3">At the end of the course, the student will be</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>An ability to understand and apply the knowledge of machine drawing as the system of communication an which an idea are expressed clearly and all information fully conveyed</td><td>K2</td></tr>
<tr><td>CO2</td><td>An ability to identify, formulates, analyzes and solves Engineering problem in optimum time</td><td>K2</td></tr>
<tr><td>CO3</td><td>Recognise to use model Engineering tools, software and equipment to analyzes different drawings design and manufacturing.</td><td>K4</td></tr>
<tr><td>CO4</td><td>An ability to use the technique skills and modern engineering tools necessary for engineering practice with the concept of virtual work</td><td>K3</td></tr>
<tr><td>CO5</td><td>Recognition of the need for, and an ability to engage in self-education and lifelong learning</td><td>K4</td></tr>
<tr><td>Course Content</td><td colspan="3">Machine Elements
1. Introduction to BIS, Drawing of simple components - Bolt, Nut, Thread profile, Keys, Cotter Joint, Riveted joints, Knuckle Joint,</td></tr>
</table>

	Shaft coupling. **Assembly and Part Drawings** 2. Sectional Views of simple Machine elements 3. Plummer block 4. Stuffing Box 5. Screw Jack 6. Connecting rod 7. Clapper block 8. Eccentric 9. Revolving centre
TEXT BOOKS	1. Machine Drawing including AutoCAD by Ajeet Singh, McGraw hill publications 2. A Primer on Computer Aided Machine Drawing-2007', Published by VTU, Belgaum. 3. 'Machine Drawing', N.D.Bhat & V.M.Panchal, Published by Charotar Publishing House, 1999 4. 'Machine Drawing', N.Siddeshwar, P.Kannaih, V.V.S. Sastry, published by Tata Mc.Grawhill, 2006 5. A Text Book of Computer Aided Machine Drawing by S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007. **6.** 'Machine Drawing', K.R. Gopala Krishna, Subhash publication.

20ME21P2-PRODUCTION ENGINEERING LABORATORY

Course Category	Program Core	**Credits**	1.5
Course type	Practical	**Lecture- Tutorial-Practical**	0-0-2
Prerequisite	Engineering Workshop Practice	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

Students undergoing this course are expected to understand:

1. To prepare mixing of sand for metal casting processes.
2. Test and correct sand mixture for metal casting processes
3. To prepare sand moulds for different kinds of patterns.
4. To inculcate various kinds of metal joining processes.
5. To shape the given metal rod into desired shape by using forging process.

Course Outcomes

At the end of the course, the student will be

CO	Course Outcomes	Knowledge Level
CO1	Understand and perform basic casting processes like moulding.	K2
CO2	Measure the different parameters in sand testing.	K5
CO3	Prepare simple green sand moulds and discus how they meet quality specification	K5
CO4	To gain the knowledge for various parameters affecting sand moulding.	K3
CO5	Compare the traditional metal joining processes with respect to the advantages, applications.	K4

Course Content

LIST OF EXPERIMENTS:

PATTERN MAKING

Model 1: Stepped Block
Model 2: Riser (Design)

SAND TESTING

Model 3: Sand Testing
Model 4: Sand Analysis

MOULDING

Model 5: Loose Piece Pattern
Model 6: Three Piece Pattern

FORGING

Model 7: S Hook
Model 8: J Hook

WELDING

Model 9: SMAW– Lap Joint
Model 10: SMAW – T Joint
Model 11: Resistance Spot Welding
Model 12: Gas Welding/Brazing

CASTING

Model 13: Casting of a Stepped Block
Model 14: Casting of a Flanged Pipe

MOULDING

Model 15: Plastic Injection Moulding

	Model 16:TRADES FOR DEMONSTRATION: 1. Machine Tools **2.** Welding **3.** Black Smithy

20ME21P3-MATERIALS SCIENCE& METALLURGY LABORATORY

Course category:	Program core	**Credits:**	2
Course Type:	Practical	**Lecture - Tutorial - Practical:**	0-0-3
Prerequisite:	Fluid Mechanics. Engineering Mathematics	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To recognize the process of specimen preparation for testing of materials
2. To acquire knowledge on basic elements of materials microstructures
3. To know various testing methods for materials

Course Outcomes

On successful completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Prepare specimen for metallographic observation.	K5
CO2	Identify the microstructure of various metals.	K3
CO3	Explain the various testing methods for materials.	K2

Course content

List of Experiments:

1. Study on Bravais lattices with the help of models.
2. Preparation of specimen for Metallographic examination of different Engineering materials.
3. Study on microstructures of ferrous metals/ alloys.
4. Study on microstructures of Non-Ferrous metals/ alloys.
5. Determination of Harden ability of steel by Jominy end Quench Test.
6. Non-destructive testing: Dye penetration testing.
7. Non-destructive testing: Magnetic particle testing.
8. Study of Iron carbon equilibrium diagram.
9. Study on heat treatment processes (hardening and tempering) of steel specimen.
10. Construct Binary phase diagram for given problems.
11. Study and capture the following of given specimens using Image acquisition software.

    a) Grain Size b) Phase Analysis. c) Inclusion Rating

	12. Study and capture the following of given specimens using Image acquisition software. a) Nodularity b) porosity measurements c) Graphite flake analysis

NBKR INSTITUTE OF SCIENCE & TECHNOLOGY: VIDYANAGAR (AUTONOMOUS)

(AFFILIATED TO JNTUA ANANTAPURAMU)

II YEAR OF FOUR YEAR B.TECH DEGREE COURSE – II SEMESTER

MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION AND EVALUATION

(With effect from the academic year 2020-2021)

S.No	Course Code	Course Title	Instruction Hours/Week			Credits	Evaluation							
							Sessional Test-I		Sessional Test-II		Total Sessional Marks (Max. 40)	End Semester Examination		Maximum Total Marks
		THEORY	L	T	D/P		Duration In Hours	Max. Marks	Duration In Hours	Max. Marks		Duration In Hours	Max. Marks	
1	20SH2201	Managerial Economics & Financial Accounting	3	0	-	3	2	40	2	40	0.8*Best of two+0.2*least of two	3	60	100
2	20ME2201	Thermodynamics-II	2	1	-	3	2	40	2	40		3	60	100
3	20ME2202	Machine Tools	3	0	-	3	2	40	2	40		3	60	100
4	20EE2204	Electrical Machines and Control Systems	2	1	2	3	2	40	2	40		3	60	100
5	20ME2203	Fluid Mechanics and Hydraulic Machinery	2	1	1	3	2	40	2	40		3	60	100
		PRACTICALS												
6	20ME22P1	Machine Tools Laboratory	-	-	3	1.5	-	-	-	40	Day to Day Evaluation and a test (40 Marks)	3	60	100
7	20EE22P3	Electrical & Electronics Engineering Laboratory	-	-	3	1.5	-	-	-	40		3	60	100
8	20CE22P3	Strength of Materials Laboratory	-	-	3	1.5	-	-	-	40		3	60	100
		SKILL ORIENTED COURSE 2												
9	20ME22SC	3D Modelling	0	0	4	2		40		40		3	60	100
		MANDATORY COURSE 2												
10	20MC2201	Environmental Science	3	-	-	-	2	40	2	40		3	60	100
		TOTAL	**15**	**03**	**16**	**21.5**	**-**	**-**	**-**	**400**		**-**	**600**	**1000**

20SH2201-MANAGERIAL ECONOMICS & FINANCIAL ACCOUNTING

<table>
<tr><td>Course category:</td><td>Humanities</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Practical</td><td>Lecture - Tutorial - Practical:</td><td>0-0-3</td></tr>
<tr><td>Prerequisite:</td><td>Basic Economics</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Explain the basic concepts of economics such as law of demand, elasticity of demand and marginal utility.
2. Describe various cost concepts in managerial decisions and also the managerial uses of production function
3. Demonstrate price and output decisions under various market structures.
4. Describe the formalities to be fulfilled to start a business organization
5. Explain the concepts and process of accounting.
6. Explain the concept of capital budgeting and Working capital management</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table><tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr><tr><td>CO1</td><td>Explain the basic concepts of economics such as law of demand, elasticity of demand and marginal utility.</td><td>K2</td></tr><tr><td>CO2</td><td>Describe various cost concepts in managerial decisions and also the managerial uses of production function.</td><td>K2</td></tr><tr><td>CO3</td><td>Demonstrate price and output decisions under various market structures.</td><td>K2</td></tr><tr><td>CO4</td><td>Show the formalities to be fulfilled to start a business organization.</td><td>K1</td></tr><tr><td>CO5</td><td>Prepare the final accounts</td><td>K4</td></tr><tr><td>CO6</td><td>Apply the knowledge of capital budgeting in long term investments.</td><td>K3</td></tr></table></td></tr>
<tr><td></td><td colspan="3">UNIT – I
BASIC CONCEPTS OF ECONOMICS: Definition of economics and basic micro and macro-economic concepts (including GDP/GNP/NI/Disposable income). The concept of demand, law of</td></tr>
</table>

Course content	demand, elasticity of demand, types and measurement, consumer's equilibrium, marginal utility analysis. **UNIT – II** **THEORY OF PRODUCTION AND COST**: Production function - Cobb-Douglas production function and its properties, law of variable proportions, law of returns to scale. Cost concepts – revenue curves, break-even analysis. **UNIT – III** **THEORY OF PRICING**: Classification of markets – Pricing under perfect competition – Pricing under monopoly – Price discrimination – Monopolistic competition. **UNIT – IV** **TYPES OF BUSINESS ORGANIZATIONS:** Sole proprietorship, partnership and joint stock company – Shares and debentures. **BANKING SYSTEM**: Central bank, commercial banks and their functions. Impact of technology in banking sector. **UNIT – V** **FINANCIAL ACCOUNTING**: Concepts and principles, journal and ledger, trial balance. **FINAL ACCOUNTS:** Trading account, profit and loss account and balance sheet -simple problems. **UNIT – VI** **FUNDAMENTAL CONCEPTS OF CAPITAL BUDGETING AND WORKING CAPITAL:** Meaning, process and methods (payback period, NPV, ARR & IRR- simple problems), working capital, operating cycle, factors and sources.
TEXT BOOKS:	1. Managerial Economics : Varshney & Maheswari, S. Chand Publishers 2. Business Organisations: C.B.Gupta , S.Chand Publishers 3. Managerial Economics and Financial Accounting: A.R.Arya Sri, Tata Mcgraw Hills publishers.
REFERENCES:	1. Economic Analysis: S.Sankaran, Margham Publications. 2. S.N.Maheswari& S.K. Maheswari, Financial Accounting, Vikas Publishers. 3. S. A. Siddiqui & A. S. Siddiqui, Managerial Economics & Financial Analysis, New age International Space Publications.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME2201-THERMODYNAMICS – II

<table>
<tr><td>Course Category:</td><td>Program Core</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture – Tutorial – Practical:</td><td>2-1-0</td></tr>
<tr><td>Pre-requisite:</td><td>Thermodynamics I</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives:</td><td colspan="3">Students undergoing this course are expected to understand:
1. To guide the students to apply the laws of thermodynamics in applications of thermal systems.
2.To help students gain essential and basic knowledge of various types of internal and external combustion engines, so as to equip them with knowledge required for the design of engines and power plants.
3. To train the students with the procedures for the testing of engines and fuels.
4. To equip the students to analyze various components of thermal power plant.</td></tr>
<tr><td>Course Outcomes:</td><td colspan="3">Upon the successful completion of the course, the students will be able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Grasp the knowledge on boilers, steam nozzles and condensers</td><td>K3</td></tr>
<tr><td>CO2</td><td>Understand the working of IC engines and evaluate their performance.</td><td>K2</td></tr>
<tr><td>CO3</td><td>Apply the laws of thermodynamics to the working of I.C engines</td><td>K3</td></tr>
<tr><td>CO4</td><td>Express the basic cycles involved in the operation of gas turbines and gain skills in problem solving for aircraft propulsion systems, in particular gas turbine engines.</td><td>K1</td></tr>
<tr><td>CO5</td><td>Describe the working of reciprocating air compressors along with their performance parameters.</td><td>K2</td></tr>
<tr><td>CO6</td><td>Discuss the operation of centrifugal and axial flow compressor</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content:</td><td colspan="3">UNIT-I
Boilers: Classification, Cochran, Babcock & Wilcox, Lamont & Benson boilers, Mountings (water level indicator, pressure gauge, safety valve and fusible plug) and Accessories (air pre- heater, economizer and super heater).
Steam Nozzles: Function of a nozzle, types, – One-dimensional steady flow of steam through a convergent and divergent nozzle.
Steam Condensers: Requirements of steam condensing plant – classification of condensers – working principle of surface and jet condensers.</td></tr>
</table>

	UNIT-II **Steam Turbines**: Classification, Impulse turbine: mechanical details – velocity diagram – condition for maximum efficiency. Methods to reduce rotor speed-velocity compounding, pressure compounding and velocity & pressure compounding, combined velocity diagram for a velocity compounded impulse turbine, condition for maximum efficiency. **Reaction Turbine**:Mechanical details – principle of operation, thermodynamic analysis of a stage, degree of reaction –velocity diagram – Parson's reaction turbine – condition for maximum efficiency. **UNIT-III** **IC Engines:** Classification, SI and CI engines - principles of operation of 4-stroke engines. Methods of fuel supply, ignition, cooling, lubrication and methods of governing. **Performance of IC engines:** Valve and port timing diagrams, Performance test - Measurement of Brake power, Indicated power, Fuel consumption, Air consumption; Heat balance test, Morse test and Retardation test on IC engine. **UNIT-IV** **Gas Turbines:** Gas turbine classification, Brayton cycle, Principles of gas turbine, Gas turbine cycles with intercooling, reheat and regeneration and their combinations. **Jet Propulsion:** Introduction to the principles of jet propulsion, Turbojet and turboprop engines and their processes, Principle of rocket propulsion, Introduction to Rocket Engine **UNIT-V** **Reciprocating Compressors**: Mechanical details, methods of compression, shaft work and isothermal efficiency of a single-stage compressor, indicator diagram, effect of clearance, volumetric efficiency, multi-stage compression - optimum pressure condition in two-stage compression, inter coolers. **UNIT-VI** **Rotary Compressors:** Comparison of reciprocating and rotary air compressors, types of rotary air compressors. **Centrifugal Compressors**: Working of centrifugal compressor, velocity triangle for moving blades of centrifugal compressor, work done by centrifugal air compressor, width of impeller blades, pre whirl. **Axial Compressor:** Working of axial flow compressor, comparison of axial flow and centrifugal compressors.
TEXT BOOKS:	1. Engineering Thermodynamic - P.K. Nag, 4th Edition, Tata McGraw Hill Education Private Limited, New Delhi. 2. A Text Book of Engineering Thermodynamics- Fourth Edition, R.K. Rajput - Lakshmi Publications. 3. Yunus A. Cengel M. and Michael A. Boles," Thermodynamics – An Engineering Approach", 8th edition, Mc Graw Hill Education(India)PrivateLimited,2014.

REFERENCES:	4. K. Ramakrishna (2011), Engineering Thermodynamics, 2nd edition, Anuradha Publishers, India 5. G.J.Van Wylen & Sonntag, "Fundamentals of Classical Thermodynamics", 4th Edition, Wiley publication 2005. 6. An Introduction to Thermodynamics- Y. V. C. Rao, Revised Edition, Universities Press, Hyderabad, India. 7. T. D. Eastop and A. McConkey, Applied Thermodynamics for Engineering Technologists, Fifth Edition, Pearson, New Delhi, 2013
e-Resources:	1. www.learnthermo.com/tutorials.php 2. www.khanacademy.org/science/physics/thermodynamics 3. www.courseera.org/learn/thermodynamics-intro 4. https://nptel.ac.in/courses/112/103/112103275

20ME2202-MACHINE TOOLS

Course Category:	Program Core	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practical:**	3-0-0
Pre-requisite:	Engineering Workshop, Basic manufacturing processes.	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives:

Students undergoing this course are expected to understand:

1. To understand the construction and operation and machining time calculations of lathe.
2. To know the construction of drilling machines, Slotting, Shaper, Planer and learn about the operations performed on these machines and tools used.
3. To know the construction of milling machines, operations performed and understand gear cutting methods in particular.
4. To know the process of grinding, grinding machine types and wheel specifications. Learn the basics of super finishing processes namely Lapping and Honing.
5. To identify the need of Non traditional methods of machining and familiarize with such processes.

Course Outcomes:

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Explain and operate various types of lathes and appreciate automation	K2
CO2	Identify deferent hole making and use appropriate machine.	K3
CO3	Identify the advantage of using multipoint cutting tools and to produce plane surface as well as complex profile.	K3
CO4	Identify the advantage of surface finish operations and advantages.	K3
CO5	Assesses of different Non – convectional machining processes depending on product applications.	K4
CO6	Explain and need, types and basic elements of an automated system for manufacturing	K2

Course Content:

UNIT I

Lathe: Specification of lathe, types of lathes, work holders, tool holders, Lathe operations and attachments for Lathes, Machining Time calculations.

Turret and capstan lathes – Comparison with engine lathe, difference between turret and capstan lathes, work holding devices and tool holding devices.

	UNIT II **Shaping, Slotting and Planing:** Principles of working, Principal parts, specification, classification, Operations performed. Shaper Mechanism, Machining time calculations. **Drilling and Boring:** Specifications, types, operations performed, tool holding devices, twist drill terminology, Boring machines, Jig Boring machines. **UNIT III** **Milling:** Specifications, classifications of milling machines, Principal features of horizontal, vertical and universal milling machines, milling operations, Types and geometry of milling cutters, methods of indexing. Gear shaping & gear hobbing, Machining Time calculations. **UNIT IV** **Grinding:** Classification of grinding machines, Cylindrical and surface grinding machines, Tool and cutter grinding machines, Grinding wheel-Different types of abrasives, bonds, designation, selection of a grinding wheel. **Broaching**: Classification, constructional features, broaching operations. **Lapping and Honing operations** **UNIT V** **Non-conventional Machining processes:** Principle and applications of AJM, WJM, USM,CM, ECM, EDM, LBM, EBM. **UNIT VI** **Automation:** Need, types and basic elements of an automated system. Levels of automation. Hardware components for automation. **Automatic lathes:** Classification, Single spindle and multi-spindle automatic lathes.
TEXT BOOKS	1. Production Technology :R.K. Jain and S.C. Gupta, New Delhi, 5th ed.,Khanna Publishers, 2010 2. Workshop Technology – Vol II :HazraChowdary, S.K. Bose & A.K. Bose, Media publishers,2005 3. Automation, production systems and CIM : M.P.Groover, pearson Education, 2008
REFERENCES	1.Manufacturing Engineering Technology : Kalpakjian, 2nd edition ,New Jersey, USA.Pearson Stores, Prentice hall Publication,2010 2. Production Technology,H.M.T. : 2nd edition Tata Mcgraw Hill, Noida-India,1986. 3. Introduction to Manufacturing Technology: PrashantT.Data, 2nd ed., JaicoPublication House,2010. 4. Workshop Technology – VolII : B.S. Raghuwanshi, New Delhi, 10th ed.,Dhanpathrai&Co, 2010.
E-Resources:	http://nptel.ac.in/courses http://iete-elan.ac.in http://freevideolectures.com/university/iitm

20EE2201- ELECTRICAL MACHINES AND CONTROL SYSTEMS

(MECHANICAL ENGINEERING)

Course Category:	Professional core	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practical:**	2-1-0
Pre-requisite:	The knowledge of principal of Electro Mechanical Energy Conversion, Fundamental concepts of magnetically coupled electric circuits, Logic circuit design, Basic knowledge of differentiation, integration, Laplace and inverse Laplace transformation techniques required.	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives:	1. To clearly learn the basic concepts of the Electrical Machines working in the modern Power System. 2. To learn the characteristics, operation and underlying theories of DC Machines. 3. To learn the characteristics, operation and underlying theories of Transformers. 4. To learn the history and need of different types of microprocessor. 5. To gain practical knowledge about linear systems and their control techniques for open loop and closed loop systems. 6. To learn the concepts of PLC and SCADA.		
Course Outcomes:	Upon successful completion of the course , the students will able to:		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Understand the constructional details and principle of operation of DC machines	K2
	CO2	Understand starting and speed control methods of DC Motors	K2
	CO3	Understand the construction, principle of operation and analyze the performance of Single phase transformers.	K4
	CO4	Evaluate different types of microprocessors.	K4
	CO5	Get knowledge of Feedback control and controller design.	K3
	CO6	Understand the PLC and SCADA	K2
	UNIT-I **DC Generators:** Constructional details-Principle of Operation-Types of Excitation,Generated EMF, Characteristics of various types of generators and applications.		

Course Content:	**UNIT-II** **DC Motors:** Torque developed in a motor, Characteristics of different types of motor and applications, Motor starters, losses and efficiency calculations. **UNIT-III** **Transformers:** Single phase transformers-Principle of operations-Construction, EMF equation, regulation, losses and efficiency, OC and SC test. **UNIT-IV** **INTRODUCTION TO MICROPROCESSORS:** Advantages and disadvantages of microprocessor, Architecture of 8085 microprocessor, pin configuration, Instruction set, Addressing modes. **UNIT-V** **Introduction to control systems:** Open loop and closed loop control systems, Transfer function, Electrical analogy of mechanical systems, Introduction to proportional, derivative and integral controllers. **UNIT-VI** **Programmable Logic Controller And SCADA:** CPU,memory,I/O modules, power supplies, programming device and system buses and remote I/Os, counter, timer -Different PLC's available in market - Selection of a PLC, SCADA- Concept and Applications
TEXT BOOKS	1."Theory and performance of Electrical machines" by J.B Gupta, S.K. Kataria & Sons publishers,2015 2."Control system Engineering" by I.J.Nagrath and M.Gopal, Wiley Eastern Ltd,Sixth edition,2017 3.Douglas V. Hall, " Microprocessors and interfacing: Programming and hard ware", TMH, 2nd edition,2007 4. "PLC and SCADA Systems" by Francis G.L
REFERENCES	1. "Performance of DC Machines" by M.G.Say, Second edition,CBS publishers. 2. "Control system Engineering" by NISE, Wiley, Fourth edition,2000. 3.A.K. Ray and K.M. Bhurchandi, " Advanced Microprocessors and Peripherals", TMH,Third edition,2009. 4. " Supervisory Control and Data Acquisition", Fourth Edition , by Stuart A Boyer**,** Book News, Inc., 2011 April
E-Resources:	http://nptel.ac.in/courses http://iete-elan.ac.in http://freevideolectures.com/university/iitm

20ME2203-FLUID MECHANICS AND HYDRAULIC MACHINERY

Course Category:	Program Core	**Credits:**	3
Course Type:	Theory	**Lecture-Tutorial-Practical:**	2-1-0
Pre-requisite:	Engineering mechanics and Fluid Mechanics	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives:	Students undergoing this course are expected to 1. To understand the basic principles of fluid mechanics 2. To identify various types of flows. 3. To understand boundary layer concepts and flow through pipes. 4. To evaluate the performance of hydraulic turbines. 5. To understand the functioning and characteristic curves of pumps		
Course Outcomes:	Upon successful completion of the course, the students will able to:		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Apply concepts of fluid statics.	K3
	CO2	Apply concepts of kinematics and dynamics for solving various fluid flow problems.	K3
	CO3	Analyze various losses in pipe flow problems and understand the measurement of flow.	K4
	CO4	Understand the concept of hydrodynamic force of jets on stationary and moving flat, inclined and curved vanes.	K2
	CO5	Explain the working and performance of various types of turbines.	K2
	CO6	Explain the working and performance of pumps.	K2

Course Content:	**UNIT-I** **Fluid Statics**: Dimensions and units- physical properties of fluids- specific gravity, viscosity and surface tension- vapour pressure and their influence on fluid motion- atmospheric gauge and vacuum pressure –measurement of pressure- Piezometer, U-Tube and Differential manometers. **UNIT-II** **Fluid Kinematics:** Stream line, path line, streak lines and stream tube-Classification of flows-steady & unsteady, uniform, non-uniform, laminar, turbulent, rotational, and irrational flows-Equation of continuity for one dimensional flow. **Fluid Dynamics**: Surface and body forces -Euler's and Bernoulli's equations for flow along a stream line, momentum equation and its application on force on pipe bend. **UNIT-III** **Closed Conduit Flow:** Reynold's experiment- Darcy Weisbach equation - Minor losses in pipes ,pipes in series and pipes in parallel - Total energy line-hydraulic gradient line. **Measurement of Flow:** Pilot tube, venturi meter, orifice meter and Flow nozzle **UNIT-IV** **Impact of free jets:** Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes, Force exerted by jet of water on series of vanes. **UNIT-V** **Hydraulic Turbines:** Classification of turbines, impulse and reaction turbines, Pelton wheel, Francis turbine and Kaplan turbine-working proportions, work done, efficiencies , hydraulic design –draft tube theory- functions and efficiency. **Performance of Hydraulic Turbines:** Geometric similarity, Unit and specific quantities, characteristic curves, governing of turbines, selection of type of turbine, cavitation, surge tank, water hammer. **UNIT-VI** **Centrifugal Pumps:** Classification, working, work done – Manometric head-losses and efficiencies specific speed- pumps in series and parallel-performance characteristic curves, NPSH. **ReciprocatingPumps:**Working, Discharge, slip, indicator diagrams.
TEXT BOOKS:	1. Hydraulics, fluid mechanics by P.N. MODI and S.M.SETH, Standard book house. 2. A text book of Fluid Mechanics and Hydraulic Machines by R.K.Bansal, Laxmi Publications.

REFERENCES:	1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, Kotaria& Sons. 2. Fluid Mechanics with engineering applications: Daugherty R.L.and J.B.Franzini TMH 10 th Edition. 3. Theory and Applications of Fluid Mechanics: Subramanyam K, Tata Mc. Graw Hill Publications.

20ME22P1 -MACHINE TOOLS LABORATORY

Course Category	Program Core	**Credits**	2
Course type	Practical	**Lecture- Tutorial-Practical**	0-0-3
Prerequisite	Machine Tools Theory	**Sessional Evaluation:**	40
		External Exam Evaluation:	60
		Total Marks:	100
		External Exam Duration:	3 hrs

Course Objective

To perform operations on lathe,shaper, milling and drilling machines and to calculate force & Power measurement on Lathe and to prepare single point cutting tool.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Perform various operations such as turning, knurling, thread cutting etc on the lathe machine.	K6
CO2	Perform various operations on shaper, milling and drilling machines.	K6
CO3	Perform alignment test on lathe	K6
CO4	Calculate force and power measurement on lathe	K5
CO5	Perform single point cutting tool on a tool cutter machine.	K6

Course Content

LIST OF EXPERIMENTS

1. Internal and External Taper Fitting
2. External Thread cutting
3. Fit Exercise on Capstan lathe
4. Indexing using Universal Dividing Head
5. Spur Gear Cutting on Milling Machine
6. Shaping Job
7. Production of Single Point Cutting Tool
8. Alignment Tests on Lathe
9. Force Measurement in Turning
10. Power Measurement in Turning

20EE22P2-ELECTRICAL & ELECTRONICS ENGINEERING LABORATORY

Course Category:	Professional core	**Credits:**	2
Course Type:	Practical	**Lecture-Tutorial-Practical:**	0-0-3
Pre-requisite:	Basic concepts of Kirchhoff's Laws, Electronic Devices& controllers. Fundamentals of DC machines.	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives:	1. To learn design and analysis of electrical circuits. 2. To learn the basic concepts of the Electrical Machines. 3. To learn the characteristics &operation of 1- φ Transformer. 4. To learn the characteristics of various Electronic Devices. 5.To learn the basic concepts of the Controllers.		
Course Outcomes:	Upon successful completion of the course , the students will able to:		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Analyze and design electrical circuits using circuit elements.	K4
	CO2	Understand power and power factor concepts practically.	K2
	CO3	Conduct load test and determine the efficiency of single phase transformer.	K5
	CO4	Obtain performance characteristics of DC Motors and Generators.	K6
	CO5	Understand the concepts of semiconductor devices.	K2
Course Content:	Minimum of 10 experiments to be conducted out of the following **LIST OF EXPERIMENTS** 1. Verification of Kirchhoff's Laws 2. Measurement of Power using Wattmeter 3. Open Circuit and Short Circuit test on 1-φTransformer 4. Load test on 1- φ Transformer 5. Load test on DC Shunt Motor 6. Excitation Characteristics of a. Separately Excited DC Generator b. Self-Excited DC Shunt Generator 7. P-N Junction Diode Characteristics (Ge& Si) 8. Zener Diode Characteristics 9. Bipolar Junction Transistor Characteristics (CE Configuration) 10. Full Wave Rectifier without Filter 11. Full Wave Rectifier with Filter 12. Design of P, PI & PID Controllers		

20CE22P3–STRENGTH OF MATERIALS LABORATORY

Course category:	Program core	**Credits:**	2
Course Type:	Theory	**Lecture - Tutorial - Practical:**	0 - 0 - 3
Prerequisite:	Knowledge on Strength of materials	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objective	To understand the mechanical testing procedures for evaluation of engineering properties of materials and to present a detailed technical report on the same.		
Course Outcomes	Upon successful completion of the course , the students will able to:		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Conduct test on mild steel for tension, direct shear, hardness, torsion and impact load	K6
	CO2	Conduct test on HYSD bar for tension, hardness, and Wood for compression test	K6
	CO3	Conduct test on springs, and rolled steel joist for bending.	K6
	CO4	Conduct test on beams for deflection and elastic modulus.	K6
	CO5	Document results in detailed technical report.	K5
Course Content	**LIST OF EXPERIMENTS** 1. Tension test on Mild Steel bar. 2. Tension test on HYSD bar. 3. Compression test on wood. 4. Direct shear test on Mild Steel. 5. Rockwell and Brinell Hardness tests. 6. Charpy and Izod Impact tests. 7. Bending test on Rolled Steel Joist. 8. Bending test on carriage springs. 9. Torsion test-Determination of Rigidity modulus (G). 10. Deflection test on simply supported beam-Determination of Elastic modulus (E). 11. Deflection test on fixed beam- Determination of Elastic modulus (E). 12. Deflection test on close-coiled helical springs. 13. Deflection test on over hanging beam - Determination of Elastic modulus (E).		

20ME22SC - 3D MODELING

(SKILL ORIENTED COURSE)

<table>
<tr><td>Course Category:</td><td>Program core</td><td>Credits:</td><td>2</td></tr>
<tr><td>Course Type:</td><td>Practical</td><td>Lecture - Tutorial - Practical:</td><td>0 - 0 –3</td></tr>
<tr><td>Prerequisite:</td><td>Engineering graphics, machine drawing</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To provide the basic techniques of three-dimensional (3-D) modeling and animation utilizing industry standard software.
2. To create 3-D geometric shapes, applying textures;
3. To provide the exposure to the principles, terms and explanations in preproduction, modeling basics, rendering basics, and animation basics.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Develop components using design software</td><td>K3</td></tr>
<tr><td>CO2</td><td>Assemble and animation of working 3D model</td><td>K6</td></tr>
<tr><td>CO3</td><td>Developing and drawing surface and sheet metal modeling</td><td>K3</td></tr>
<tr><td>CO4</td><td>Design piping and wire harnessing</td><td>K6</td></tr>
</table></td></tr>
<tr><td>Course content</td><td colspan="3">List of Experiments for 3D Modeling Laboratory
1. Part Modeling
2. Drawing & Detailing
3. Assemble
4. Surface Modeling
5. Sheet Metal Modeling
6. Piping Design
7. Wire Harness Routing Design
Minimum one exercise from each above module and maximum 8 exercises</td></tr>
</table>

20MC2102 - ENVIRONEMNTAL SCIENCE

Course category:	Mandatory Course	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3-0-0
Prerequisite:	Basic knowledge in Social Sciences and chemistry	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objective

1. To understand the multidisciplinary nature of environmental studies and features of ecosystem and bio-diversity.
2. To understand the management of major natural resources.
3. To understand and recognize the causes, effects and remedial measures of environmental pollution and outline the disaster management.
4. To understand various environmental cases-studies and classify different environmental acts.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Understand multidisciplinary nature of environmental studies.	K2
CO2	Understand the features of ecosystem and bio-diversity.	K2
CO3	Understand the management of major natural resources.	K2
CO4	Understand the causes, effects and remedial measures of environmental pollution.	K2
CO5	Understand effectives of elements on environment and disaster management.	K2
CO6	Familiar with environmental acts and must be able to apply the knowledge of environmental studies to certain case studies.	K3

Course Content

UNIT- I

Introduction:
Definition, Scope and Importance of Environmental Studies. Various Components of Environment-Atmosphere, Biosphere, Hydrosphere and Lithosphere. Multidisciplinary nature of Environmental Studies and public awareness.

UNIT- II

Ecosystems: Concept, Structure and function, Producers composers and decomposers, Energy flow, Ecological succession, Food chains, webs and ecological pyramids, Characteristics structures and functions of ecosystems such as Forest, Grassland, Desert, Aquatic ecosystems.

UNIT- III

Natural Resources and associated problems:
Land Resources: Land as a resource, land degradation, man induces

	landslides, soil erosion, and desertification. **Forest resources**: Use and over-exploitation, deforestation, case studies, Timber extraction, mining, dams and their effects on forests and tribal people. **Water resources:** Use and over-utilization of surface and groundwater, conflicts over water sharing and watershed management. **Mineral Resources**: Use and exploitation, environmental effects of extracting and using mineral resources. **Food Resources**: World food problems, changes caused by agriculture and over grazing, effects of modern agriculture, fertilizers- pesticides problems, water logging, salinity, **Energy Resources**: Growing energy needs renewable and non-renewable energy sources use of alternate energy sources. **UNIT- IV** **Biodiversity and Conservation**: Definition, Genetic, Species, and Ecosystem diversity, Value of biodiversity at global, national, local levels, Hot spots of biodiversity, Threats to Biodiversity, Endangered and endemic species of India, In-situ and ex-situ conservation of biodiversity. **Case Studies**: Silent Valley Project, Mathura Refinery and Tajmahal, Tehri Dam, Kolleru Lake Aquaculture, Fluorosis in Andhra Pradesh. **UNIT- V** **Environmental Pollution**- Definition, Causes, effects and control of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, Ozone layer depletion, Global Warming and Acid Rains. Solid waste management methods-Composting, Vermi composting, Landfill. Disaster management, floods, earthquake, cyclone and landslides. **UNIT- VI** **Environmental Problems in India:** Effect of Urbanization, Industrialization and Transportation on quality environment and public health. Drinking water, Sanitation for good health. Green revolution. Social, Economic and Environmental interaction for sustainable development. **Environmental Acts:** Wateract, Air act, Environment protection act, Wildlife protection act, Forest conservation act. Coastal Regulation Zones (CRZ), Special Economic Zones (SEZ). **Field Work**: Visit to a local area having river / forest / grassland / hill/ mountain to document and environmental assets. Study of local environment- common plants, insects, birds. Study of simple ecosystems-pond, hill slopes, etc. Visits to Industries, water treatment plants, effluent treatment plants.
TEXT BOOKS:	1. BharuchaErach, *Biodiversity of India*, Mapin Publishing Pvt. Ltd., Ahmadabad, 2002. 2. Environmental Science by Anubha Kaushik and C.P.Kaushik
REFERENCES:	1. Introduction to Environmental science by Y.Anjaneyulu. 2. Environmental Studies by Dr.B.S.Chauhan. 3. Environmental Science by M.Chandra Sekhar.

N.B.K.R. INSTITUTE OF SCIENCE & TECHNOLOGY

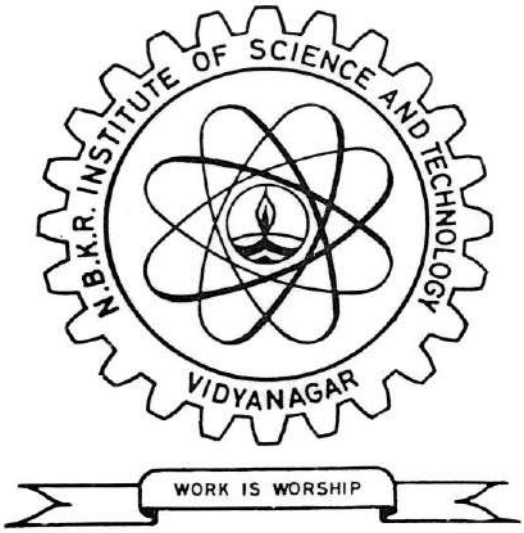
(AUTONOMOUS)

COLLEGE WITH POTENTIAL FOR EXCELLENCE (CPE)

Affiliated to JNTUA, Ananthapuramu

Re-Accredited by NAAC with 'A' Grade

B.Tech. Courses Accredited by NBA under TIER-I



SYLLABUS

B.TECH. DEGREE COURSE

III B.TECH

I & II Semesters

MECHANICAL ENGINEERING

(With effect from the batch admitted in the academic year 2020-2021)

VIDYANAGAR - 524413
SPSR Nellore-Dist. Andhra Pradesh
www.nbkrist.org

INSTITUTE VISION

To emerge as a comprehensive Institute that provides quality technical education and research thereby building up a precious human resource for the industry and society.

INSTITUTE MISSION

- To provide a learner-centered environment that challenges individuals to actively participate in the education process.
- To empower the faculty to excel in teaching while engaging in research, creativity and public service.
- To develop effective learning skills enabling students pick up critical thinking thus crafting them professionally fit and ethically strong.
- To share human and academic resources with industries, schools and public agencies through partnerships and outreach activities.

VISION OF THE DEPARTMENT

To become an excellent centre for technical education and research in the field of mechanical engineering to meet the societal, regional, national and global challenges.

MISSION OF THE DEPARTMENT

M1: To impart quality technical education and transform bud engineers into an effective and responsible engineers to work with the current technologies in multi-cultural and multi-discipline environment.

M2: To encourage the students to develop their creativity in the field of mechanical engineering by providing modern laboratory facilities with hands on training and contemporary curriculum.

M3: To develop the interaction with the Industry experts to gain practical knowledge.

M4: To provide best teaching & learning practices as well as creating opportunities for Research, maximise student results and placements.

M5: To inculcate and promote lifelong learning skills, problem solving skills, leadership qualities and team work.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: A strong foundation to access, analyze, plan and implement their knowledge in basic sciences & mathematics, core and interdisciplinary courses.

PEO 2: Graduate will be in a position to work with the members of multi-disciplinary teams and can play a leading role in handling the technical issues.

PEO 3: Graduates will have capability to work with modern engineering tools, software and equipment under the realistic constraints.

PEO 4: Graduates will engage in lifelong learning skills with research attitude and social responsibility.

PROGRAM OUTCOMES(POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review the research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO11 **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.

PO12 **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.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1 Solve engineering problems in the area of Robotics and Automation.

PSO2 Design, Simulate and Analyze using CAD/CAM/CAE tools.

B Tech **R20 Regulations**

N B K R Institute of Science & Technology:: Vidyanagar

MECHANICAL ENGINEERING Course Structure (R20) – III Year

III B.Tech

Semester -V						
S.No	Course Code	Course Name	L	T	P	Credits
1	20ME3101	Theory of Machines-I	3	0	0	3
2	20ME3102	Design of Machine Elements - I	3	0	0	3
3	20ME3103	Engineering Metrology and Instrumentation	3	0	0	3
4	20ME31E1	**Professional Elective-I**	3	0	0	3
5	20ME31O1	**Open Elective -I**	3	0	0	3
Laboratories						
6	20ME31P1	Thermal Engineering Laboratory	0	0	3	1.5
7	20ME31P2	Fluid Mechanics and Hydraulic Machinery Laboratory	0	0	3	1.5
Skill Advanced Course-I						
8	20ME31SC	Simulation laboratory	1	0	2	2
Mandatory Course-III						
9	20MC3101	Professional Ethics &Intellectual Property Rights	2	0	0	0
Internship						
10	20ME31IN	Evaluation of Community Service Project/ Internship				1.5
					Total	**21.5**

S.No	PROFESSIONAL ELECTIVE-I
1.	CAD/CAM
2.	Flexible Manufacturing Systems
3.	Welding Technology
4.	Tribology

S.No	OPEN ELECTIVE - 1
1.	Industrial Engineering & Management
2.	Total Quality Management
3.	Quality Control and Reliability

20ME3101-THEORY OF MACHINES – I

<table>
<tr><td>Course Category:</td><td>Programme core</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course type:</td><td>Theory</td><td>Lecture- Tutorial-Practical:</td><td>3-0-0</td></tr>
<tr><td>Prerequisite:</td><td>Engineering Mechanics</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Students are made to learn
❖ Concept of machines, mechanisms and related terminologies
❖ Become familiar and understanding of the most commonly used mechanisms
❖ The concept of analysis of different mechanisms
❖ The theory of gears, gear trains brakes and dynamometers</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">After completing the course the student will be able to
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Identify and demonstrate different links, kinematic pairs.</td><td>K3</td></tr>
<tr><td>CO2</td><td>Analyse the velocity and accelerations of various links of any mechanism</td><td>K4</td></tr>
<tr><td>CO3</td><td>Apply the concepts of gears for the calculation of velocity ratio of gear trains</td><td>K3</td></tr>
<tr><td>CO4</td><td>Apply the concepts of friction for the design of various clutches</td><td>K3</td></tr>
<tr><td>CO5</td><td>Describe the classification of brakes and dynamometers and their applications.</td><td>K2</td></tr>
<tr><td>CO6</td><td>Describe the classification of governors and their applications.</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
Kinematic Links, Pairs and Chains
Kinematic Links & Pairs: Element, link, types of links – rigid link, flexible link, fluid link. Constrained relative motions –completely, successfully and incompletely type. Kinematic pair, classification of kinematic pairs – lower, higher, sliding, turning, rolling, screw, spherical, Degrees of freedom-Grubler’s criteria.
Kinematic Chain: Kinematic chain, types- four bar chain, single slider-crank chain and double slider-crank chain. Grashoff’s law, inversions of four bar chain, single slider-crank chain.
Mechanisms: Introduction, mechanism, machine, Crank & Slotted lever quicker turn motion mechanism, condition for correct steering, Davis steering gear.</td></tr>
</table>

	UNIT – II **Kinematic Analysis** **Velocity Analysis:** Absolute and Relative motions, motion of a link,velocity of rubbing, velocity diagrams for four bar mechanism, singleslider mechanism and quick return motion mechanisms, Instantaneous Center, Kennedy's theorem. **Acceleration Analysis:** Acceleration diagrams for four bar and single slidermechanism, Introduction to Coriolis component of acceleration. **UNIT – III** **Toothed Gearing and Gear Trains** **Gears:** Classification of Gears, gear terminology, law of gearing, velocity ofsliding, path of contact, arc of contact, number of pairs of teeth in contact, interference in involute gears and minimum number of teeth toavoid interference. **Gear Trains:** Simple gear train, compound gear train, reverted gear train, planetary or epicyclic gear train, velocity ratio of epicyclic gear train (tabular method). Simple problems on gear trains. **UNIT – IV** **Friction & Clutches** **Friction:**Uniformpressure,uniform wear, friction circle and friction axis. Lubricated surfaces- boundary friction, filmLubrication. **Clutches:** Single disc or plate clutch, multiple disc clutches, cone clutch and centrifugalclutch. **UNIT – V** **Brakes & Dynamometers** **Brakes:** Simple shoe brake, block brake, band brake and disc brake. **Dynamometers**: Absorption- rope, belt. Transmission - torsion and epi-cyclic **UNIT – VI** **Governors:** Introduction, Watt, Porter and Proell governors, spring loaded governors -Hartnell governor. Sensitiveness, isochronism, stability, hunting, effort and power.
TEXT BOOKS:	1. Theory of Machines: R.S.Khurmi and J K Gupta, S.Chand publication, 2015 2. Sadhu Singh, Theory of Machines, Pearson Education, New Delhi 3. Theory of Machines: S S Rattan, 4th ed., McGraw Hill Education., India Pvt. Ltd., 2014
REFERENCES:	1. Mechanisms and Machine Theory : Rao J. S. and Dukkipati R. V., 2nd ed., New Age, 2006 2. Theory of Machines: Thomas Bevan, 3rd ed., Pearson Education India, 2010. 3. J.S. Rao and R.V. Dukkipati [2008], Mechanisms and Machine Theory
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME3102-DESIGN OF MACHINE ELEMENTS–I

Course Category:	Program core	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3- 0 - 0
Prerequisite:	Engineering Mechanics, SOM	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To understand procedure of machine design and develop an ability to apply it for simple component design by using design data hand book.
2. To apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
3. To apply mechanical engineering design theory to identify and quantify machine elements in the design of commonly used mechanical systems.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Understand the process of design and basic procedure of machine.	K2
CO2	Evaluate stresses in machine elements subjected to torsion, bending and impact loads.	K4
CO3	Formulate the procedure under fatigue loading and evaluate the design parameters. element	K4
CO4	Understand and apply the design considerations and procedures involved in riveted and bolted joints.	K2
CO5	Understand and apply the design considerations and procedures involved in threaded joints.	K2
CO6	Calculate the design parameters for the shafts using design data hand book.	K4

Course Content

UNIT – I

Engineering Design: What is designing? The process of design, Design by evolution, morphology of design, Identification of need, true need, brain storming, economic and financial feasibility.

Machine Design: Basic procedure of machine design– Design considerations and standards; Engineering materials- classification and selection, mechanical properties of materials.

UNIT – II

Design For Static Strength: Modes of failure; factor of safety; Simple stresses in machine parts-Stresses due to bending moment, Stresses due to torsional moment – Eccentric axial loading-Design for impact loads..

	UNIT – III **Design For Fatigue Strength:** Stress concentration – Stress concentration factors - Reduction of stress concentration- Fluctuating stresses – Fatigue failure – Endurance limit – Notch sensitivity– Soderberg, Goodman and modified Goodman diagrams – Design for infinite life. **UNIT – IV** **Riveted Joints**: Types of riveted joints - efficiency of riveted joint – eccentrically loaded riveted joints. **Welded Joints:** Types of welded joints; stresses in butt and fillet welds; strength of welded joints; eccentricity welded joint; weld joint subjected to bending moment. **UNIT – V** **Threaded Joints:** Terminology of screw threads, Bolted joint -Eccentrically loaded bolted joints in shear - Eccentric load perpendicular to axis of bolt -Bolts of uniform strength. **UNIT – VI** **Shafts:** Introduction-Design of solid and hallow shafts for strength and rigidity, Shaft materials, Shaft sizes- BIS Codes. Design of shafts for combined bending and axial loads.
TEXT BOOKS:	1. Design of Machine Elements: Bhandari V. B., 4th Ed.McGraw Hill Education,2017 2. Machine Design: Khannaiah P., Scitech Publications. 4th edition, 2010 3. Machine Design: Sharma P.C. & Aggarwal D.K., S. K. Kataria& Sons, 2006
REFERENCES:	1. Machine Design: Khurmi R.S., S. Chand Publisher, 14th ed., 2010. 2.Mechanical Engineering Design: Shigley J. E., 9th ed., Tata McGraw-Hill Education 2010 3.Balaveera Reddy &Mahadevan, Design Data Handbook for Mechanical Engineers, CBS publishers, 4th Edition, 2013. **NOTE**: Balaveera Reddy &Mahadevan, Design Data Handbook for Mechanical Engineers, CBS publishers, 4th Edition, 2013
E-Resources:	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME3103-ENGINEERING METROLOGY & INSTRUMENTATION

Course Category:	Program core	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3 - 0 - 0
Prerequisite:	Engineering Mechanics, Basic Electrical & Electronics Engineering	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To develop in students the concept of tolerance, limits and fits.
2. To understand the principle of small as well as large angular measurements and interferometry applied to metrology.
3. To identify the elements of surface texture, screw threads and toothed gears.
4. To understand the basic construction of any measuring system and characteristics.
5. To understand the principles underlying measurement of pressure, temperature, flow, force and torque.
6. To understand the principles of strain gauges and vibration measurement.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Apply to achieve desired precision in production shop as well as proper assemblies.	K3
CO2	Perform precise linear, angular and other geometry checks.	K4
CO3	Assess quality of any surface as well as check screw thread and geared toothing.	K4
CO4	Assess the instrument capabilities for any application as well as analyse the truth and validity of experimental data.	K4
CO5	Select flow meters, temperature & pressure sensors, and force as well as torque sensors suitable for particular applications.	K3
CO6	Carry out strain measurement for members loaded in different configurations.	K4

Course Content

UNIT – I

Introduction to Metrology: Line and end standards, concept of tolerance. Interchangeability and selective assembly. Limits and fits - systems of limits and fits according to Indian standards and ISO standards. Limit gauges- Taylor's principles - Gauge tolerance and wear allowance.

Comparators: Mechanical Comparators: Johansson Mikrokator and dial Indicators, Mechanical - Optical comparator, LVDT and Solex pneumatic comparator

UNIT – II

Angle Measurement: Angle gauges, Protractors, Levels, Clinometers and Sine bar. Profile projector, Autocollimator and Tool maker's Microscope. Straightness, Flatness, Squareness and Roundness Testing. Application of slip gauges, rollers and spheres in angle measurement.

	Interferometry: Interference of light, optical flat and sources of light, lasers. NPL flatness and gauge length interferometers. **UNIT – III** **Surface Finish:** Importance, Elements of surface texture, R_a, R_t & R_z and sampling length. Instruments for measuring Surface Roughness – Tomlinson surface meter, Talysurf, Piezoelectric instruments. Plastic Replica method. Introduction to area surface roughness. **Screw Thread Measurement:** Pitch and angle errors, concept of VED, measurement of major, minor and effective diameters (two wire and three wire methods). **Gear Measurement**: Involute Form Tester, Rolling Gear Tester, Tooth thickness measurement - Chordal thickness andBase Tangent method. **UNIT – IV** **Basics of Instrumentation:** Functional elements of an Instrument. Static characteristics: Span and Range, Readability, Sensitivity, accuracy, Precision, Threshold, Resolution, Hysteresis and Calibration curve. Dynamic characteristics: Generalized equation of measuring system, examples of zero, first and second order system. Types of input. Behaviour of first order system to step Input. Types of experimental errors, combination of component errors in overall system accuracy. **Transducers** – Resistance, Capacitance, Piezoelectric and Photoelectric transducers. **UNIT – V** **Measurement of Flow**: Ultrasonic flow meters, Rotameters, turbine flow meter and magnetic flow meter, Measurement of fluid velocities – Pitot tube, hot wire anemometer. **Measurement of Temperature:** Expansion Thermometers, thermocouples, Resistance thermometers and Pyrometers. **Measurement of Force and Torque:** Basic force measurement methods, hydraulic and pneumatic load cells, Torsion meters. **UNIT – VI** **Measurement of Pressure and Vacuum:** Bourdon pressure gauge, Bellows and Diaphragm gauge. Vacuum measurement – Mcleod gauge, Pirani gauge and Thermocouple vacuum gauge. **Strain Measurement:** Strain measurement by Electrical Resistance Strain gauge for bending, compressive and tensile strains. **Vibration and acceleration measurement:** Piezo electric and seismic accelerometers
TEXT BOOKS:	1. A Text Book of Engineering Metrology:R.K.Jain, Khanna Publishers, 2009 2. Metrology for Engineers, John Frederick Wise Galyer, Charles Reginald Shotbolt,Cassell P L C, 1990 3. Mechanical measurements and Control Engg: Kumar D.S., Metropolitan Book Company, 2006

	4. Mechanical measurements : Beckwith T.G. & Lewis Buck N., Addison-Wesley Longman, 2002
REFERENCES:	1. A Text Book of Engineering Metrology I.C Gupta., Dhanpat Rai publishers, 2008 2. Engineering Metrology - Mahajan Dhanpat Rai Publishers, 2009 3. Production Technology - HMT Tata Mc Graw-Hill Education 2001 4. Experimental methods for Engineer: Holmen J.P., 8th ed., Tata McGraw-Hill 2009 5. A Course in Mechanical measurements and Instrumentation – A.K.Sawhney& P. Sawhney – Dhanpatrai& Co P. Ltd. New Delhi – twelfth edition 2017 6. Mechanical measurement: Sirohi R.S. &Radha Krishna H.C., 3rd ed., New Age International, 2009
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

PROFESSIONAL ELECTIVE -I

20ME31E1 CAD/CAM

(Professional Elective-I)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3- 0 - 0
Prerequisite:	AutoCAD, CAMD	**Sessional Evaluation :**	40
		External Exam Evaluation:	60
		Total Marks:	100
		External Exam Duration:	3 hrs

Course Objectives

The general objectives of the course are to enable the students to

1. Understand the basic analytical fundamentals that are used to create and manipulate geometric models in computer programs.
2. To visualize how the components looks like before its manufacturing or fabrication
3. To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
4. To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc.
5. To understand the different types of curves like Bezier curve, B-Spline curve & Graphics Standards 6. To understand different Algorithms for optimization of drawing of basic entities

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces	K2
CO2	Use parametric 3D CAD software tools in the correct manner for making geometric part models and different wireframe primitives using parametric representations	K3
CO3	Create surface primitives using parametric modeling and solid primitives using the different representation schemes.	K4
CO4	Apply the concepts of machining for the purpose of selection of appropriate machining centers, machining parameters, select appropriate cutting tools for CNC and programming.	K3
CO5	Perform design and analysis of automatic storage and retrieval system to solve the design problems of different type of transfer mechanism	K4
CO6	Identify the various elements and their activities in the Computer Integrated Manufacturing Systems.	K3

Course Content	**UNIT – I** **INTRODUCTION TO CAD**: Design process, product cycle, applications of computers for design, benefits of CAD. **COMPUTER GRAPHICS**: 2D Transformations, points and lines transformation - translation, rotation, scaling, mirror, reflection. Introduction to 3D transformations, windowing and clipping. **UNIT – II** **GEOMETRY MODELING:** Modeling concepts - 2D and 3D, comparison between wire frame modeling, surface modeling and solid modeling. **WIRE FRAME MODELING**: Parametric and non-parametric representation of curves - line, circle, ellipse, cubic spline, B-splines, Bezier curve. Hidden line algorithm. **UNIT – III** **SURFACE MODELING:** Surface description, parametric representation of cylindrical surface, ruled surface, surface of revolution, cubic, B-Splines and Bezier surfaces. **SOLID MODELING:** CSG and B-Rep methods. **UNIT – IV** **CNC:** Numerical control, numerical control modes, numerical control elements, DNC, CNC and applications of CNC. Additive manufacturing- Definition, advantages and applications. **PART PROGRAMMING**: ISO based G & M codes for NC part programming, Manual part programming, and computer Aided Part Programming (APT). Simple programming exercise on turning, boring and drilling operations **UNIT – V** **CIM**: Definition, divisions of CIM, advantages and disadvantages. **GROUP TECHNOLOGY**: Introduction, concepts of GT, classification and coding System-OPTIZ, application of GT **FMS**: Definition, need, flexibilities, components, advantages. **COMPUTER AIDED PROCESS PLANNING**: Variant and Generative CAPP systems. U**NIT – VI** **AUTOMATIC IDENTIFICATION METHODS:** Bar code Technology, QR code, contact & non-contact type, concepts and uses. **BASIC CONCEPTS OF SHOP FLOOR DATA**: Types of factory data and collection systems. Introduction to IIOT. **AUTOMATED MATERIAL HANDLING SYSTEMS**: AS/RS, Conveyers – types, RGVS, AGVS and their applications.
TEXT BOOKS:	1.Automation Production System &CIM :Groover M.P., Pearson, 4th ed., 2016 2.CAD / CAM: Ibrahim Zeid, Tata McGraw Hill, 5th Reprint, 2010 3. Mathematical Elements of Computer Graphics: Rogers and Adams, McGraw Hill, 2017.
REFERENCES:	1. CAD/CAM: Groover M.P., Pearson, 2003. 2 .Computer Graphics: Steven Harrington, McGraw Hill, 2nd ed., 2014. 3.CAD/CAM:Besant and Lui, E. Horwood publisher, 1986
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME31E2 - FLEXIBLE MANUFACTURING SYSTEMS

(Professional Elective-I)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3- 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Basic Manufacturing Processes</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Understand the role of Flexible Manufacturing Systems(FMS) in manufacturing,
2. Understand the concept of Group Technology
3. Understand the concept of Cellular Mfg Systems
4. Understand the benefits of automation,</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Classify and distinguish FMS and other manufacturing systems including job-shop andmass production systems.</td><td>K4</td></tr>
<tr><td>CO2</td><td>Explain processing stations and material handling systems used in FMS environments.</td><td>K2</td></tr>
<tr><td>CO3</td><td>Design and analyze FMS using simulation and analytical techniques.</td><td>K4</td></tr>
<tr><td>CO4</td><td>Understand tool management in FMS.</td><td>K2</td></tr>
<tr><td>CO5</td><td>Analyze the production management problems in planning, loading, scheduling, routing and breakdown in a typical FMS.</td><td>K4</td></tr>
<tr><td>CO6</td><td>Recall the benefits of automation</td><td>K1</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
INTRODUCTION TO FMS: Definition of FMS, types and configuration concepts, types of flexibility and performance measures. Functions of FMS host computer, FMS host and area controller function distribution.
Smart Manufacturing: Importance, advantages and applications

UNIT – II
DEVELOPMENT AND IMPLEMENTATION OF FMS: Planning phases, integration, system configuration, FMS layouts, simulation, FMS project development steps. Project management, equipment development, host system development, planning, hardware and software development.
UNIT – III
DISTRIBUTED NUMERICAL CONTROL: DNC system – communication between DNC computer and machine control unit – hierarchical processing of data in DNC system – features of DNC system.</td></tr>
</table>

	UNIT – IV **AUTOMATED MATERIAL HANDLING:** Function, types, analysis of material handling equipment. Design of conveyor and AGV systems. **AUTOMATED STORAGE:** Storage system performance, AS/RS, carousel storage system, WIP storage, interfacing handling storage with manufacturing. **UNIT – V** **PROGRAMMABLE LOGIC CONTROLLERS:** Components of PLC, PLC operating cycle, additional capabilities of a PLC, programming the PLC, Ladder logic diagrams, counters etc. Industrial process control using PLC. **UNIT – VI** **FMS RATIONALE:** Economic and technological justification for FMS, GT, JIT, operation and evaluation, personnel and infra structural aspects, typical case studies and future prospects.
TEXT BOOKS:	1. Automation, production systems and computer integrated manufacturing: Groover M. P, Prentice Hall India (P) Ltd., 2002. 2. Flexible manufacturing system: Shivanand H. K., Benal M. M and Koti V, New Age International (P) Limited. Publishers, 2006
REFERENCES:	1. Flexible manufacturing : Parrish D. J, Butterworth – Heinemann Ltd, 1990 2. Intelligent Manufacturing Systems: .Kusiak A., Prentice Hall, Englewood Cliffs, NJ, 1990 3. Performance modelling of automated manufacturing systems : Viswanadhan N. and Narahari Y, Prentice Hall India (P) Ltd., 1992 4. The design and operation of FMS : Ranky P. G, IFS Pub, U. K, 1998
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME31E3 - WELDING TECHNOLOGY

(Professional Elective-I)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3 - 0 - 0
Prerequisite:	Basic Manufacturing process and Machine Tools	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. Evaluate potential hazards and apply procedures to maintain workplace safety with respect to welding applications.
2. Theoretical and practical analysis of various Welding techniques
3. To understand the power sources related to the welding processes.
4. Theoretical exposure on special welding processes EBM, LBM, AHW etc.
5. To learn Destructive and Non- Destructive Testing (NDT).

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Select tools and equipment to support welding as well as related activities.	K3
CO2	Apply problem solving and decision making skills to overcome obstacles in welding industries.	K3
CO3	Evaluate weld quality and generate recommendations for continuous improvements in welded structures.	K4
CO4	Select appropriate welding techniques for the applications.	K3
CO5	Apply correct welding procedures to achieve the quality	K3
CO6	Compare Destructive and Non- Destructive Testing	K4

Course content

UNIT –I

GAS WELDING: Introduction, Gases, Production of Oxygen and Acetylene, Setup and Equipment, Cylinder valves, Pressure regulators, Welding torches, Types of flames, Gas Welding techniques, Filler rods, Fluxes rods, Fluxes, Oxy hydrogen welding.Applications of Gas welding process for cutting.

UNIT – II

ARC WELDING: Carbon Arc Welding, Metal arc Welding, TIG welding, MIG welding, submerged arc welding. DC generators, AC Transformers, Rectifiers, B.I.S. Classifications of Electrodes for Arc

	welding, Coating of electrodes and Plasma arc welding. Applications of arc welding process for cutting. **UNIT – III** **SPECIAL WELDING PROCESSES**: Electron beam Welding, Laser welding, Thermit welding, Atomic Hydrogen welding, soldering, Brazing, Braze welding, Adhesive bonding, Metal spraying. **Introduction to** arc based additive manufacturing **UNIT – IV** **PRESSURE WELDING PROCESS:** Forge welding, Friction welding, Explosive welding, Ultrasonic welding and Diffusion bonding. **RESISTANCE WELDING:** Spot & Seam Projection welding, Flash Butt welding and Upset welding. Heat balance in Resistance welding. **UNIT – V** **DEFECTS IN MATERIALS:** Casting defects, Forging defects**,** Rolling defects**,** Extrusion defects**,** Drawing defects & Welding defects.Cause of Material failure & Types of Material failure. **UNIT – VI** **DESTRUCTIVE AND NON- DESTRUCTIVE TESTING (NDT)** – Introduction to destructive and non-destructive testing, X-ray and Gamma ray testing, testing of pipe, plate, boiler, drum etc., Magnetic particle testing, Liquid penetrant testing, Ultrasonic testing.
TEXT BOOKS:	1. Welding and Welding Technology :Little, Richard L, McGraw-Hill Companies, 1993 2. Welding Processes and Technology :R.S. Parmar, Khanna Publishers, 2nd ed., 1995
REFERENCES:	1. Welding Technology :Konigsberger F., Hart Pub. Co., 1968 2.Welding Technology: O.P.Khanna, DhanpatRai& Sons, 1993 3.Welding Engineering &Technology: Parmar R.S, 2nd ed., Khanna Publishers, 2010
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME31E4 – TRIBOLOGY

(Professional Elective-I)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3 - 0 - 0
Prerequisite:	Material Science, DME-I and II	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To provide overview of tribology and practical implications in machine elements.
2. To understand the material properties, nature of surfaces, their topography and surface characterization techniques.
3. To understand the genesis of friction, the theories/laws.
4. To learn about wear, wear mechanisms, wear theories applied in machine elements.

Course Outcomes

Upon successful completion of the course, the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Apply the principles of lubrication, lubrication regimes, and theories of hydrodynamic, elasto hydrodynamic and mixed / boundary lubrication.	K3
CO2	Explain essentials of tribotesting and experimental techniques in Tribology.	K2
CO3	Discuss and formulate tribological modeling and simulation.	K4
CO4	Design of mechanical components against wear.	K4
CO5	Recall wear, wear mechanisms, wear theories applied in machine elements	K1
CO6	Analyze genesis of friction, the theories/laws	K4

Course Content

UNIT – I

FRICTION AND LUBRICATION:

Elements of tribology, friction theories, measurement methods, friction of metals and non-metals. Causes of Friction, Adhesion Theory, Abrasive Theory, Junction Growth Theory, Laws of Rolling Friction and Friction Instability. Viscosity, flow of fluids, viscosity and its variation, absolute and kinematic viscosity, temperature variation, viscosity index, determination of viscosity, different types of viscometers.

UNIT – II

WEAR: Classification and mechanisms of wear, delamination theory, debris analysis, testing methods and standards. Related case studies.

Wear Mechanisms- Adhesive Wear, Abrasive Wear, Corrosive Wear, Fretting Wear and Wear Analysis

	UNIT-III **HYDROSTATICLUBRICATION:** Hydrostatic step bearing, application to pivoted pad thrust bearing and other applications, hydrostatic lifts, hydrostatic squeeze films and its application to journal bearing. **UNIT-IV** **HYDRODYNAMIC THEORY OF LUBRICATION:** Various theories of lubrication, Petroff's equation, Reynold's equation in two dimensions, effects of side leakage, Reynolds equation in three dimensions, friction in sliding bearing, hydro dynamic theory applied to journal bearing, minimum oil film thickness, oil whip and whirl anti-friction bearing **UNIT – V** **FRICTION AND POWER LOSSES IN JOURNAL BEARINGS:** Calibration of friction, loss friction in concentric bearings, bearing modulus, Sommer field number, heat balance, practical consideration of journal bearing design considerations. **UNIT – VI** **SURFACE ENGINEERING:** Concept and scope of surface engineering. Surface modification – transformation hardening, surface melting, thermo chemical processes. Surface Coating – plating, fusion processes, vapor phase processes. Selection of coating for wear and corrosion resistance**.** **BEARING MATERIALS:** General requirements of bearing materials, types of bearing materials.
TEXT BOOKS:	1. Fundamentals of Tribology: Basu, SenGupta and Ahuja, New Delhi, 2nd edition, PHI, 2005. 2. Tribology in Industry: Sushil Kumar Srivatsava, Hyderabad, 5th edition, S. Chand&Co, Publisher, 2007.
REFERENCES:	1. Introduction to Tribology in Bearings: B.C. Majumdar New Delhi, 2nd Edition, S.Chand& Co. Publishers, 2012. 2. Engineering Tribology : PransantaSahoo, PHI Pvt.Ltd, 2005 3. Handbook of tribology: materials, coatings and surface treatments, B.Bhushan, B.K. Gupta, McGraw-Hill,1997. 4.Basic Lubrication Theory, A. Cameron, Ellis Hardwoods Ltd., UK. 5.Friction and Wear of Materials, Ernest Rabinowicz, John Wiley sons,1995. 6.Tribology, Friction and Wear of Engineering Material: I. M.Hutchings, Edward Arnold, London,1992.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

OPEN ELECTIVE-I

20ME31O1 - INDUSTRIAL ENGINEERING AND MANAGEMENT (Open Elective-I)

Course Category:	Open Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3- 0 - 0
Prerequisite:	Managerial Economics & Financial Accounting	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. Identify and implement effective solutions to real problems.
2. Contemporary industrial engineering tools and cutting-edge technology in production.
3. Graduates will be able to formulate problems accurately, alternatives, and decision makers in a fashion that facilitates decision-making processes.
4. Graduates will be able to assume leadership roles with strong communication skills and will be able to work competently and ethically alone and as team members

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Apply knowledge of science & engineering in industrial management	K3
CO2	Take the right decisions to optimize resources utilization by improving productivity of the Lands, Buildings, People, Materials, Machines, Money, Methods and Management effectively.	K4
CO3	Eliminate unproductive activities under the control of the Management, Supervisor, worker and the Design of Products and Processes	K4
CO4	Use the Charts to record the Activities of the people, materials and Equipment to find alternative methods which minimize waste and to implement the best method.	K3
CO5	Improve the processes and find the Standard Time.	
CO6	Design the Man – Machine System to improve Human Efficiency and reduce the effort of the workers.	K4

Course Content

UNIT – I

MANAGEMENT CONCEPT: Administration, management and organization. Scientific management, functions of management, principles of management, types of organizations, principles of organization, Fayol's and Taylor's contributions to management.

PRODUCTION: Systems concept of production, Types of Production – Continuous production (Mass production, process production and

	assembly lines) and Intermittent production (Job type and Batch type). **UNIT – II** **SALES FORECASTING:** Need, classification. Methods - moving average, exponential smoothing and linear regression. Measures of forecast accuracy. **MARKETING:** Definition, principles and functions, marketing management, marketing research. **UNIT – III** **PLANT LOCATION:** Influencing factors, Weber's theory. Choice of city, suburban and country locations. **PLANT LAYOUT:** Definition, objectives. Types – Product, process and fixed position layouts. **PLANT MAINTENANCE:** Importance, Types – Preventive, predictive and breakdown maintenance. Introduction to total productive maintenance (TPM). **UNIT – IV** **WORK STUDY:** Basic procedure. Method study – definition, objectives and procedure. **WORK MEASUREMENT:** Objectives. Techniques of work measurement – Time study, work sampling, analytical sampling and Predetermined Motion Time Systems (PMTS). Determination of standard Time. **UNIT – V** **PERSONNEL MANAGEMENT:** Functions of personnel management. Methods of Job evaluation. Methods of merit rating. Incentive plans – Piece rate system, Taylor's differential piece rate system, Halsey 50-50 plan, Rowan plan and Bedaux system. **UNIT – VI** **QUALITY CONTROL:** Introduction to inspection and quality control. Variables and Attributes. Acceptance sampling for attributes – description, advantages and disadvantages of sampling, types of sampling plans, OC curve for single and double sampling plans. Design of sampling plans. **TOTAL QUALITY MANAGEMENT:** Introduction, Six Sigma concept, tools for continuous quality improvement.
TEXT BOOKS:	1. Industrial Engineering and Management: Khanna O P, Dhanpat Rai & Sons, 2018 2. Principles of Motion and Time Study: Ralph Barnes, John Wiley, 2003 3. Quality control : Dale H Besterfield, Pearson Education, 2009
REFERENCES:	1. Production and Operations Management : R. Panneerselvam, PHI Publications, 2012 2. Modern Production/Operations Management : Buffa E S, John Wiley & Sons. 2007
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME31O2 - TOTAL QUALITY MANAGEMENT

(Open Elective-I)

<table>
<tr><td>Course Category:</td><td>Open Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 - 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Industrial Engineering and Management</td><td>Sessional Evaluation :
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1.To provide students' knowledge about basic concepts of Quality and to describe it in its broader perspective
2. To provide a forum for discussion on quality, and to provide an exposure and discussion on quality issues.
3. To analyze some existing methods and techniques of quality management within discussion on quality issues.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table><tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr><tr><td>CO1</td><td>Evaluate the principles of quality management and to explain how these principles can be applied within quality management systems</td><td>K4</td></tr><tr><td>CO2</td><td>Identify the key aspects of the quality improvement cycle and to select and use appropriate tools and techniques for controlling, improving and measuring quality</td><td>K3</td></tr><tr><td>CO3</td><td>Critically appraise the organizational, communication and teamwork requirements for effective quality management</td><td>K4</td></tr><tr><td>CO4</td><td>Critically analyze the strategic issues in quality management, including current issues and developments, and to devise and evaluate quality implementation plans</td><td>K4</td></tr><tr><td>CO5</td><td>Understand the structure and functions of quality council in order to drive TQM implementation</td><td>K2</td></tr><tr><td>CO6</td><td>Efficiently designing the effective performance measurement system</td><td>K4</td></tr></table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
TQM: overview , concepts, elements – History, Quality management philosophies Juran, Deming, Crosby, Feigenbaum, Ishikawa – Stages of evolution, continuous improvement, objectives, internal and external customers.
UNIT – II
PROCESS MANAGEMENT: Quality measurement systems (QMS) – developing and implementing QMS, nonconformance database, TQM tools & techniques, 7 QC tools, 7 New QC tool</td></tr>
</table>

	UNIT – III **PROBLEM SOLVING TECHNIQUES:** Problem solving process, corrective action, order ofprecedence, system failure analysis approach, flow chart, fault tree analysis, failure mode assessment and assignment matrix, organizing failure mode analysis and pedigree analysis. **UNIT –IV** **QUALITY CIRCLES:** Organization, Focus Team approach – Ishikawa diagram, Quality Function Deployment (QFD), Elements of QFD, Bench Marking – Types, Advantages & limitations of Benchmarking. **UNIT – V** **TAGUCHI METHOD**: Taguchi Analysis, Loss Function, Taguchi Design of Experiments, Deming Cycle. **UNIT – VI** **QUALITY STANDARDS**: Need of standardization, Institutions, Bodies of Standardization, ISO 9000 Series, ISO 14000 Series, other contemporary standards. Six Sigma Approach – Application of Six Sigma approach to various industrial situations.
TEXT BOOKS:	1. Total Quality Management : Joseph & Susan Berk, Sterling Publishers, 1994. 2. Total Quality Management : Besterfield, 3rd Edition, Pearson Education India, 2003.
REFERENCES:	1. Quality Management Systems - A Practical Guide :Howard S Gitlow, CRC Press, 2000. 2. Managing for Quality & Performance Excellence : James R. Evans. 9th ed., 2013. 3. Quality management : KanishkaBedi, Oxford Univ. Press, India, 2006. 4. Total Quality Management:B.SenthilArasu and J. Praveen Paul, 2nd ed., Scitech, 2007.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME31O3 - QUALITY CONTROL AND RELIABILITY
(Open Elective-I)

Course Category:	Open Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3 -0 - 0
Prerequisite:	Managerial Economics & Financial Accounting	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

- Demonstrate the approaches and techniques to assess and improve process and/or product quality and reliability.
- Introduce the principles and techniques of Statistical Quality Control and their practical uses in product and/or process design and monitoring
- Illustrate the basic concepts and techniques of modern reliability engineering tools.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Understand the basic techniques of quality improvement, fundamental knowledge of statistics and probability	K2
CO2	Categorize the process in control or out of control using various types of charts (p, np, C, U charts).	K4
CO3	Utilise control charts to analyze for improving the process quality	K3
CO4	Design different sampling plans and identify the sampling plan suitable for the process.	K4
CO5	Discuss the various parameters of life testing of components such as MTTF,MTBF	K4
CO6	Understand the concepts of reliability and maintainability	K2

Course content

UNIT – I

QUALITY CONTROL: Introduction to inspection and quality control, objectives of statistical quality control, chance and assignable causes of variation, control chart basic principles.

CONTROL CHARTS FOR VARIABLES: $\bar{x}$ and R charts, interpretation of control charts.

UNIT – II

PROCESS CAPABILITY ANALYSIS: Specification limits and control limits, natural tolerance limits, specifications and process capability, process capability indices, setting tolerances on assemblies and components.

	UNIT – III **CONTROL CHARTS FOR ATTRIBUTES**: P chart, C chart, U chart, sensitivity analysis of P charts, quality Rating System. **UNIT – IV** **ACCEPTANCE SAMPLING PLANS FOR ATTRIBUTES**: Types of sampling plans, advantages and disadvantages of sampling plans, evaluation of sampling plans – OC curve, characteristics of OC curve, producer risk and consumer risk, AOQ, AQL, ATI, ASN. Double sampling plan – OC curve. **UNIT – V** **RELIABILITY**: Concepts of reliability, scope, Importance of reliability, reliability data collection. Failure data analysis: MTTF, MTBF, failure rate, hazard rate. **SYSTEM RELIABILITY**: Series, parallel and mixed configurations. **RELIABILITY IMPROVEMENT**: Active and standby redundancies, introduction to fault tree analysis. **UNIT – VI** **QUALITY COSTS**: Prevention, appraisal, internal failure and external failure costs, total quality management, quality function deployment, tools for continuous quality improvement. **QUALITY CIRCLES**: Concepts, objectives and advantages. Introduction to six sigma concept. Features of ISO 9000 quality system - Classification, need, advantages and limitations.
TEXT BOOKS:	1. Quality Control: Dale H Besterfield, Pearson Education, 2006. 2. Statistical Quality Control: Gupta R.C., Khanna Publishers, 2008. 3. Statistical Quality Control: M. Mahajan.,Dhanpat rai & Co., 2009.
REFERENCES:	1. Fundamentals of Quality Control and Improvement : AmitavaMitra, PHI, 2009 2. Concepts in Reliability Engineering:Srinath L.S., East West Press, 2009.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME31P1-THERMAL ENGINEERING LABORATORY

<table>
<tr><td>Course Category:</td><td>Program core</td><td>Credits:</td><td>1.5</td></tr>
<tr><td>Course Type:</td><td>Practical</td><td>Lecture - Tutorial - Practical:</td><td>0-0-3</td></tr>
<tr><td>Prerequisite:</td><td>TD-I &TD-II</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Students undergoing this course are expected to
1. Demonstrate and conduct experiments, interpret and analyze data and report results of IC Engine testing
2. Study and performance testing of air compressor and air blower.
3. Impart training to draw valve timing diagrams & port timing diagrams on IC engine models.
4. Demonstrate and conduct experiments, interpret and analyze data and report results of Computerized VCR IC Engine testing</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Conduct performance test on I.C. Engines</td><td>K4</td></tr>
<tr><td>CO2</td><td>Compare various methods used to determine frictional horse power of the engine</td><td>K4</td></tr>
<tr><td>CO3</td><td>Identify parts, mechanisms of an IC Engine and the significance of IC Engines</td><td>K3</td></tr>
<tr><td>CO4</td><td>Conduct performance test on reciprocating compressor</td><td>K4</td></tr>
<tr><td>CO5</td><td>Conduct load test on air blower and plot characteristic curves</td><td>K4</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">List of Experiments:
1. Load Test and Smoke Test on I.C. Engines.
2. Morse Test on Multi-Cylinder Engine.
3. Heat balance sheet on I.C. Engines.
4. Study of Multi-Cylinder Engine and determination of its firing order.
5. Performance Test on Air Compressor.
6. Study of Automobile Mechanisms.
7. To draw the crank angle vs. pressure diagram for an I.C. engine using pressure transducer and cathode ray oscilloscope.
8. Load Test and Emission Test with 3-Gas Analysis & smoke meter on four stroke diesel engine with Bio-diesel fuel.
9. Performance Test on centrifugal blower.
10.Economical Speed Test & volumetric efficiency test on I.C engine.
11.Retardation Test on an I.C. Engine.
12.Test for optimum flow rate of cooling water for an I. C. Engine.
13.VTD on 4 Stroke Diesel Engine model
14.VTD on 4 Stroke Petrol Engine model
15.PTD on 2 Stroke Diesel Engine model</td></tr>
</table>

20CE31P2-FLUID MECHANICS AND HYDRAULIC MACHINERY LABORATORY

Course Category:	Program core	**Credits:**	1.5
Course Type:	Practical	**Lecture - Tutorial - Practical:**	0-0-3
Prerequisite:	FM & HM	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To provide practical knowledge in verification of principles of fluid flow
2. To impart knowledge in measuring pressure, discharge and velocity of fluid flow
3. To understand Major and Minor Losses
4. To gain knowledge in performance testing of Hydraulic Turbines and Hydraulic Pumps at constant speed and Head

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Analyze the fluid flow principles	K4
CO2	Determine performance analysis in turbines and pumps and can be used in power plants	K5
CO3	Analyze practical problems in all power plants and chemical industries	K4
CO4	Conduct experiments (in teams) in pipe flows and open-channel flows and interpreting data from model studies to prototype cases, as well as documenting them in engineering reports.	K5
CO5	Analyze a variety of practical fluid-flow devices and utilize fluid mechanics principles in design	K4

Course Content

List of Experiments:

1. Discharge Measurements:
(a) Small Orifice
(b) Venturi Meter
(c) Orifice Meter
(d) Triangular Notch
(e) Rectangular Notch
(f) Elbow Meter (Pipe-bend Meter)
2. Losses in Pipes:
(a) Pipe Friction
(b) Sudden Contraction
(c) Sudden Expansion
(d) Gate Valve
(e) Bend Loss
3. Determination of Efficiency in Pumps and Turbines:
(a) Centrifugal Pump
(b) Francis Turbine
(c) Kaplan Turbine

20ME31SC- SIMULATION LABORATORY

BASICS OF LABVIEW

(Skill Advanced Course)

<table>
<tr><td>Course Category:</td><td>Skill Advanced Course</td><td>Credits:</td><td>2</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>0 -0-4</td></tr>
<tr><td>Prerequisite:</td><td>Basic programming skills</td><td>Sessional Evaluation :
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Iinteractively acquire and analyze single-channel and multi-channel data from NI DAQ devices and instruments.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon completion of this course, students will be able to
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Utilize features which will reconfigure the general physical and software layouts of the LabVIEW programming environment</td><td>K3</td></tr>
<tr><td>CO2</td><td>Program execution through arrays, clusters and structures.</td><td>K5</td></tr>
<tr><td>CO3</td><td>Measure and control physical phenomena through laboratory exercises and projects.</td><td>K5</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
Introduction to LabVIEW: Software Environment, Front Panel and Block Diagram Toolbar, Front Panel Control and Indicators

UNIT – II
Modular Programming: Icon and Connector Pane, Repetition and Loops - For Loop, While Loop; Shift Registers, Feedback Nodes, Control Timing, Local and Global Variable

UNIT – III
Arrays : One, Two and Multi-dimensional Array; Initializing, Deleting, Inserting and Replacing Elements; Array Functions, Auto Indexing

UNIT – IV
Clusters-Creating, Operations, Assembling and Disassembling Clusters Conversion between Arrays and Clusters

UNIT – V
Structures - Case Structures, Sequence Structures, Customizing Structures, Timed and Event Structures
Plotting Data - Graphs, Charts , Customizing Graphs and Charts</td></tr>
</table>

	UNIT – VI String and File I/O - Creating, Editing and Formatting Strings , Basics and Choosing of File I/O Introduction to DAQ & Other Modules **Exercises** 1 Circuit building and data extraction using NI myDAQ 2 Sensor Measurement using NI myDAQ 3 Signal Processing using NI myDAQ 4 Interfacing of NI myRIO with Button Keypad 5 Interfacing of NI myRIO with Bluetooth Interface 6 Interfacing of NI myRIO with Microphone for data recording 7 Interfacing of NI myRIO with LCD and LED Display 8 Interfacing of NI myRIO with Digital Potentiometer 9 Interfacing of NI myRIO with Temperature Sensor 10 Interfacing of NI myRIO with 3-axis Digital Compass 11 Interfacing of NI myRIO with 3-axis Digital Accelerometer 12 Interfacing of NI myRIO with 3-axis Digital Gyro 13 Interfacing of NI myRIO with H-Bridge driver with feedback inputs 14 Interfacing of NI myRIO with Ambient Light Sensor 15 Interfacing of NI myRIO with IR Range Sensor 16 Interfacing of NI myRIO with Ultrasonic Sensor 17 Interfacing of NI myRIO with DC Motor 18 Interfacing of NI myRIO with Servomotor – Standard and Continuous Rotation
TEXT BOOKS:	1. Let Us LabVIEW part 1 & Part 2,, NitheshPradan, 1st edition, Notion Press, 2020 2. Virtual Instrumentation Using Labview, Jerome J, Prentice Hall India Learning Private Limited, 2010.
REFERENCES:	1. Virtual Instrumentation using LABVIEW, Sanjay Gupta, McGraw Hill Education; 2nd edition, 2017. 2. LabVIEW for Everyone: Graphical Programming Made Easy and Fun, by Travis, Jeffrey; Kring, Jim, Prentice Hall, 2007 (3rd Edition)
E-Resources	https://www.ni.com/en-in/shop/services/education-services/customer-education-courses/

BASICS OF MATLAB

(Skill Advanced Course)

Course Category:	Skill Advanced Course	**Credits:**	2
Course Type:	Theory	**Lecture - Tutorial - Practical:**	0 -0-4
Prerequisite:	Basic Programming Skills	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives	To know about fundamentals of MATLAB tool and solve mechanical engineering problems		
Course Outcomes	Upon completion of this course, students will be able to		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Implement loops, branching, control instruction and functions in MATLAB programming environment.	K6
	CO2	Program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.	K5
	CO3	Understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.	K2
	CO4	Simulate MATLAB Simulink examples	K6
Course Content	**UNIT-1** Introduction to MATLAB Programming:Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples. **Unit- II** Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit. **UNIT-III** Numerical Integration and Differentiation: Trapezoidal method, Simpson method. **UNIT-IV** Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss siedal and Newton-Raphson method. **UNIT- V** Ordinary Differential Equations: Introduction to ODE's, Euler's method, second order RungaKutta method, MATLAB ode45 algorithm in single variable and multivariables. Transforms: Discrete Fourier Transforms, ,		

	SOET **UNIT- VI** MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape. **EXERCISES** 1. Basic MATLAB operations 2. Basic matrix operations. 3. Solve linear equations 4. Solution of linear equations for underdetermined and over determined cases 5. Program for two dimensional plotting 6. Program for three dimensional plotting 7. Program to solve differential equations 8. Determination of roots of a polynomial 9. Program for interpolation and curve fitting 10. Evaluate numerical differentiation 11. Evaluate numerical integration 12. Create a simple model in Simulink
TEXT BOOKS:	1 A Guide to MATLAB For Beginners and Experienced Users By Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, Kevin R. Coombes, John E. Osborn, Garrett J. Stuck, 2006, Cambridge University Press 2 MATLAB For Dummies By Jim Sizemore, John Paul Mueller , 2014, Wiley 3 Learning MATLAB A Problem Solving Approach By Walter Gander, 2015, Springer International Publishing
REFERENCES:	1. Programming with MATLAB for Scientists A Beginner's Introduction, Eugeniy E. Mikhailov · 2018 2.MATLAB Programming for Engineers, Stephen J. Chapman · 2015
E-Resources:	**https://www.mathworks.com/help/matlab/**

20MC3101 – PROFESSIONAL ETHICS AND INTELLECTUAL PROPERTY RIGHTS

<table>
<tr><td>Course Category:</td><td>Mandatory</td><td colspan="2">Credits:</td><td>0</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td colspan="2">Lecture-Tutorial-Practical:</td><td>2-0-0</td></tr>
<tr><td rowspan="4">Pre-requisite:</td><td rowspan="4">-</td><td colspan="2">Sessional Evaluation:</td><td>40</td></tr>
<tr><td colspan="2">End Exam Evaluation:</td><td>60</td></tr>
<tr><td colspan="2">Total Marks:</td><td>100</td></tr>
<tr><td colspan="2">External Exam Duration:</td><td>3 hrs.</td></tr>
<tr><td>Course Objectives:</td><td colspan="4">Students undergoing this course are expected to:
1. Explain different kind of ethics and values.
2. Apply professional ethics in Engineering.
3. Explain the role of IPRs in professional life.
4. Elucidate the importance of patents and copyrights</td></tr>
<tr><td rowspan="7">Course Outcomes:</td><td colspan="4">After completing the course, the student will be able to:</td></tr>
<tr><td>CO</td><td colspan="2">Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td colspan="2">Understand Ethics and different types of values.</td><td>K2</td></tr>
<tr><td>CO2</td><td colspan="2">Understand Engineering Ethics and their usage.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Understand IPR.</td><td>K2</td></tr>
<tr><td>CO4</td><td colspan="2">Understand Patents.</td><td>K2</td></tr>
<tr><td>CO5</td><td colspan="2">Understand patent problems and solutions.</td><td>K2</td></tr>
<tr><td>CO6</td><td colspan="2">Understand Trademark and their need.</td><td>K2</td></tr>
<tr><td>Course Content:</td><td colspan="4">UNIT – I
Human Values : Morals, Values-types of values, Ethics, Integrity, Work ethics, Service learning, Virtues-civic virtues, Respect for others, Living peacefully, Caring, Sharing, Honesty, Courage, Valuing time, Cooperation, Commitment, Empathy, Self-confidence, Challenges in the work place. Spirituality-Spirituality in the Workplace, Spirituality for Corporate Excellence. Introduction to Yoga and meditation for professional excellence and stress management.

UNIT – II
Engineering Ethics: Senses of “Engineering Ethics”, Variety of moral issues, Types of inquiries, Moral dilemma-Definition, Steps to solve dilemma. Moral Autonomy, Moral development–Kohlberg theory, Gilligan’s theory. Consensus and Controversy. Profession-Definition, Characteristics. Models of professional roles, Responsibility-Senses, Types, Responsible Professionalism, Social Responsibility, Accountability, Obligation. Theories about right action-Uses and criteria, Ethical theories. Self-interest, Customs and Religion, Self-respect.</td></tr>
</table>

	UNIT – III **Intellectual Property Rights:** Introduction to Intellectual property law, Types of intellectual property, Importance of intellectual property, Agencies responsible for intellectual property Registration, Regulatory-Compliance and Liability issues. **UNIT– IV** **Patents:** Introduction to Patents, What can be patented, What can be not patented, Publication Vs Patent, Types of Patents, Objects for Patenting an invention, Main steps of patenting procedure, Patent application procedure in India, Obtaining Patents, Rights and Obligations of a Patentee. **UNIT– V** **Protection of Patents –** Introduction, Applying for Patent Protection in a Single Country, Protection under the Paris Convention, Protection under the Patent Cooperation Treaty. Royalty of Patents, Types of Royalties. Legal Problems with patents, Solutions to patent problems. **UNIT – VI** **Trade Marks:** Definition, Function of trademark, Essentials of trade mark, Trade mark registration, Key features of trade mark, Advantages of trade mark assignment, Protectable matter, Selecting and evaluating trademark.
TEXT BOOKS:	1. R.S. Naagarazan: Professional Ethics and Human Values, New Age International Publishers. 2. Deborah E Bouchoux: Intellectual Property - The Law of Trademarks, Copyrights, Patents and Trade Secrets, DELMAR CENGAGE Learning,4th Edition, 2013.
REFERENCES:	1. Narayanan P.: Intellectual Property Law, Eastern Law House (2007) 3rd Edition. 2. P. Radhakrishnan- Intellectual Property Rights.
e-Resources:	**http://nptel.ac.in/courses**

N B K R Institute of Science & Technology:: Vidyanagar

MECHANICAL ENGINEERING Course Structure (R20) – III Year

III B.Tech

Semester -VI						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1	20ME3201	Theory of Machines-II	3	0	0	3
2	20ME3202	Design of Machine Elements - II	3	0	0	3
3	20ME3203	Heat Transfer	3	0	0	3
4	20ME32E1	**Professional Elective-II**	3	0	0	3
5	20ME32O1	**Open Elective-II**	3	0	0	3
Laboratories						
6	20ME32P1	Heat Transfer laboratory	0	0	3	1.5
7	20ME32P2	Dynamics and Vibration laboratory	0	0	3	1.5
8	20ME32P3	Engineering Metrology and Instrumentation Laboratory	0	0	2	1.5
Skill Advanced Course-II						
9	20ME32SC	Robotics Simulation	0	0	2	2
Mandatory Course -IV						
10	20MC3201	Entrepreneurship	2	0	0	0
					Total	**21.5**
Industry Internship (Mandatory) for 6 - 8 weeks duration during summer vacation						

S.No	**PROFESSIONAL ELECTIVE-II**
1.	Industrial Robotics
2.	Composite Materials
3.	Supply Chain Management
4.	Energy Conservation and Management
5.	MOOCS (NPTEL/SWAYAM) Course (12 Weeks Duration)

S.No	**OPEN ELECTIVE – II**
1	Operation Research
2	Design of Experiments
3	Work Study

20ME3201 - THEORY OF MACHINES-II

<table>
<tr><td>Course Category:</td><td>Programme core</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course type:</td><td>Theory</td><td>Lecture- Tutorial-Practical:</td><td>3-0-0</td></tr>
<tr><td>Prerequisite:</td><td>Engineering Mechanics, Theory of Machines-I</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">Students are made to learn
❖ Fundamental knowledge of dynamics of machines so that they can appreciate problems of Turning moment diagrams and Flywheel, Gyroscopic couple and precessional motion.
❖ Analytical and graphical methods for calculating balancing of rotary and reciprocating masses.
❖ Vibrations and its significance on engineering design.
❖ Cam profile for various types of followers.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">After completing the course the student will be able to
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Identify and demonstrate different links, kinematic pairs.</td><td>K3</td></tr>
<tr><td>CO2</td><td>Determines the velocity and accelerations of various links of any mechanism</td><td>K4</td></tr>
<tr><td>CO3</td><td>Apply the concepts of gears for the calculation of velocity ratio of gear trains</td><td>K3</td></tr>
<tr><td>CO4</td><td>Apply the concepts of friction for the design of various clutches</td><td>K3</td></tr>
<tr><td>CO5</td><td>Describe the classification of brakes and dynamometers and their applications.</td><td>K1</td></tr>
<tr><td>CO6</td><td>Describe the classification of governors and their applications.</td><td>K1</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I

Turning Moment Diagrams and Flywheel
Turning moment diagrams for steam engine, I.C. engine and multi cylinder engine. Crank effort - fluctuation of energy, coefficient of fluctuation of speed – flywheel of a punching press
UNIT – II

Gyroscopic Couple and Precessional Motion
Gyroscopic couple, effect of precession on stability of moving vehicles- motor cycles, motor cars, aero-planes and ships.
UNIT – III
CAMS
Classifications of cams and followers, displacement, velocity & acceleration diagrams when the followers move with uniform velocity, S.H.M., uniform acceleration &retardation, Construction of cam profiles for radial cam with knife edge follower, roller follower. Cams with specified contours-tangent cam</td></tr>
</table>

	UNIT – IV **Balancing of Rotating and Reciprocating Masses** **Balancing of Rotating Masses**: Static and dynamic balance. Balancing of single rotating mass in the same plane, single rotating mass using two masses rotating in different planes, several masses rotating in the same plane and different planes - using analytical and graphical methods. **Balancing of Reciprocating Masses**: Partial balancing of locomotives, variation of tractive effort, swaying couple and hammer blow, balancing of single cylinder **UNIT – V** **Longitudinal, Transverse Vibrations** &**Torsional Vibrations** **Longitudinal and Transverse Vibrations:** Introduction– Single degree of freedom system, differential equation of motion – free longitudinal vibrations, transverse vibrations of beams with concentrated and distributed loads- energy method, Dunkerly's method Whirling of shafts. **Torsional Vibrations:** Single, two and three rotor systems and torsionally equivalent shaft. **UNIT – VI** **Damped and Forced Vibrations** **Damped Vibrations**: Introduction, types- free damped vibrations- under, critical and over damped systems. Damping ratio and logarithmic decrement. **Forced Vibrations**: Equations of motion. Vibration analysis on 1-DOF and 2-DOF systems (simple treatment).
TEXT BOOKS:	1. Theory of Machines: R.S.Khurmi and J K Gupta, S.Chand publication, 2015 2. Sadhu Singh, Theory of Machines, Pearson Education, New Delhi 3. Theory of Machines: S S Rattan, 4th ed., McGraw Hill Education., India Pvt. Ltd., 2014
REFERENCES:	1. Mechanisms and Machine Theory : Rao J. S. and Dukkipati R. V., 2nd ed., New Age, 2006 2. Theory of Machines: Thomas Bevan, 3rd ed., Pearson Education India, 2010. 3. J.S. Rao and R.V.. Dukkipati [2008], Mechanisms and Machine Theory
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME3202 - DESIGN OF MACHINE ELEMENTS-II

<table>
<tr><td>Course Category:</td><td>Program core</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 -0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>DME-I</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To understand use of different types keys, couplings, springs and determine safe design under given conditions by using design data hand book.
2. To apply the concepts of stress analysis, theories of failure and material science to analyze, design and/or select commonly used machine components.
3. To understand the standard nomenclature, forces, failures, application, design procedure of Spur and Helical gears and to determine standard geometry under given loading condition by using design data hand book.
4: To identify different parts of I.C.Engine and apply design procedure.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Understand and apply the procedure for the design of keys and couplings</td><td>K2</td></tr>
<tr><td>CO2</td><td>Calculate the design parameters and selection of various types of bearings.</td><td>K4</td></tr>
<tr><td>CO3</td><td>Understand the functions of various types of mechanical springs and apply the procedure for the design of mechanical springs</td><td>K2</td></tr>
<tr><td>CO4</td><td>Recall the various terms of gears and apply the design procedure for the spur and helical gears.</td><td>K1</td></tr>
<tr><td>CO5</td><td>Recall the various terms of gears and apply the design procedure for the Bevel and worm gears.</td><td>K1</td></tr>
<tr><td>CO6</td><td>Understand the mechanism of I.C. Engine parts and calculate the design parameters for different elements of engine component.</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
Keys and Couplings: Introduction-Types of keys- Design of square and flat keys; Design of splines. Types of couplings- Rigid couplings: Muff, split muff and Flange couplings.

UNIT – II
Bearings: Introduction, Journal bearings – Lubrication – Bearing Modulus–bearing materials – journal bearing design.
Ball and roller bearings: Static and dynamic loading of ball and roller bearings, bearing life and reliability, selection of ball bearings.
Introduction to magnetic and ceramic bearings.</td></tr>
</table>

	UNIT – III **Mechanical Springs:** Introduction - Classification of springs; Stress and deflections of helical springs; Springs for fatigue loading; Concentric springs; Design of multi-leaf springs. **UNIT – IV** **Spur & Helical Gears:** Types of gears and their applications, gear materials, allowable stresses, Spur gears: Terminology, force analysis, Design of spur gears – Lewis equation. Check for dynamic load and wear load. Helical Gears-Terminology, design of helical gears. Check for wear load. **UNIT – V** **Bevel & Worm Gears**: Bevel gears - Terminology, types of bevel gears, force analysis, design of bevel gears. Worm gears: Terminology, materials for gearing, force analysis, design of worm gears, check for wear and lubrication. **UNIT-VI** **I.C. Engine Parts**: Pistons, Forces acting on piston – Construction Design and proportions of piston. Connecting rod: Thrust in connecting rod – stress due to whipping action on Connecting rod ends. **Introduction to Design of Electric Vehicle Parts**
TEXT BOOKS:	1. Design of Machine Elements : Bhandari V. B., 3rd ed., Tata McGraw-Hill Education 2. Machine Design: Khannaiah P., Scitech Publications.
REFERENCES:	1. Machine Design: Khurmi R.S., S. Chand Publisher, 14th ed., 2010. 2.Mechanical Engineering Design: Shigley J. E., 9th ed., Tata McGraw Hill Education 2010 3. Machine Design: Sharma P.C. & Aggarwal D.K, S.K.Kataria& Sons, 2006 **NOTE:** Balaveera Reddy &Mahadevan, Design Data Handbook for Mechanical Engineers, CBS Publishers, 4th Edition, 2013.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME3203 - HEAT TRANSFER

<table>
<tr><td>Course Category:</td><td>Program core</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 - 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>TD-I, TD-II and FM&HM</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Understand the fundamentals of Conduction heat transfer and measure the heat transfer through Homogeneous slabs, hollow cylinders, sphere, extended surfaces and fins.
2. Understand the fundamentals of fins and measure the transient heat conduction through systems with negligible internal resistance and systems with negligible surface resistance
3. To measure convective mode of heat transfer and derive exact and approximate solutions for convection problems
4. Understand the fundamentals of radiation heat transfer and measure heat transfer during radiation, boiling and condensation. To measure heat transfer through different types of heat exchangers</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Recall modes of heat transfer, dimensionless numbers and classifications of heat exchangers</td><td>K1</td></tr>
<tr><td>CO2</td><td>Understand laws of conduction, convection, radiation and predict the losses in heat exchange components</td><td>K2</td></tr>
<tr><td>CO3</td><td>Apply laws and concepts of conduction for 1D steady state heat conduction problems</td><td>K3</td></tr>
<tr><td>CO4</td><td>Apply laws and concepts of convection for simple geometries</td><td>K3</td></tr>
<tr><td>CO5</td><td>Analyze and identify problems related to heat transfer in heat exchangers</td><td>K4</td></tr>
<tr><td>CO6</td><td>Choose proper heat exchanger for heat exchange applications</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
INTRODUCTION: Modes of heat transfer, basic laws of heat transfer, general heat conduction equation in cartesian, cylindrical and spherical coordinate systems.
STEADY STATE HEAT CONDUCTION (without internal heat generation and for 1D, Isotropic): Electrical analogy of heat conduction-Expressions for heat flow rate, temperature distribution-Plane slab, hollow cylinder and sphere, composite wall, cylinder and sphere. Overall heat transfer coefficient, critical thickness of insulation.</td></tr>
</table>

	UNIT – II **FINS:** Fins of uniform cross section, governing equation, temperature distribution and heat dissipation rate for long fin, short fin with and without insulated tip. Efficiency and effectiveness of fins. **ONE DIMENSIONAL TRANSIENT HEAT CONDUCTION:** Lumped heat analysis, significance of Biot and Fourier numbers, heat flow in an infinitely thick plate and chart solutions of transient conduction systems. **UNIT – III** **FORCED CONVECTION:** **External Flows:** Concepts of hydrodynamic and thermal boundary layer, use of empirical correlations for convective heat transfer - flat plates and cylinders. **Internal Flows:** Concepts of hydrodynamic and thermal entry lengths, use of empirical relations for horizontal pipe flow and annulus flow. **UNIT – IV** **DIMENSIONAL ANALYSIS:** Buckingham's π-theorem, Reynolds Number, Prandtl Number, Nusselt Number, Grashoff Number and Stanton Number - their definition and significance. **FREE CONVECTION:** Development of hydrodynamic and thermal boundary layer along a vertical plate – Use of empirical relations for vertical plates and pipes. **UNIT – V** **HEAT EXCHANGERS:** Introduction, classification of heat exchangers, logarithmic mean temperature difference (LMTD), area calculation for parallel and counter flow heat exchangers, effectiveness of heat exchangers, NTU method of heat exchanger design. **UNIT – VI** **RADIATION:** Theories of thermal radiation- absorption, reflection and transmission. Monochromatic and total emissive power, black body concept, Planck's distribution law, Wien's displacement law, Stefan Boltzmann law, Lambert's cosine law, Kirchhoff's law. Shape factor, heat transfer between black and grey surfaces, radiation shields.
TEXT BOOKS:	1. Heat Transfer: J.P. Holman, Tata McGraw-Hill Education, 2008 2. Fundamentals of Engineering Heat & Mass Transfer: Sachadeva R.C, New Age Science, 2009 3. Heat and Mass Transfer : D S Kumar, S. K. Kataria& Sons, 2009
REFERENCES:	1. Principles of Heat Transfer: Frank kreith, Cengage Learning, 2010 2. Fundamentals of Heat & Mass Transfer: F.P. Incropera & D.P Dewitt, 5th ed., John Wiley and Sons, New York,2002. 3. Heat and Mass Transfer: Yonus Cengel, Tata McGraw-Hill Education, 2014.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

PROFESSIONAL ELECTIVE-II

20ME32E1-INDUSTRIAL ROBOTICS

(Professional Elective-II)

(Also Offered as Open Elective for Other Branches)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3- 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Mathematics,
Programming</td><td>Sessional Evaluation :
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To acquire the knowledge and need of industrial robotics
2. To develop the ability to analyze the drives for articulated systems
3. To acquire the knowledge description of motion.
To develop an ability to use software tools for analysis and design of robotic systems</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Gain knowledge about the importance of robotics in today and future and robot configuration and subsystems</td><td>K3</td></tr>
<tr><td>CO2</td><td>Gain knowledge about robotic accessories such as sensors grippers</td><td>K3</td></tr>
<tr><td>CO3</td><td>Understand about robot path planning</td><td>K2</td></tr>
<tr><td>CO4</td><td>Develop skills in kinematics of robot motion</td><td>K4</td></tr>
<tr><td>CO5</td><td>Understand competence in Design and implementation programming of robot systems</td><td>K2</td></tr>
<tr><td>CO6</td><td>Gain knowledge about Industrial robots applications.</td><td>K3</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
INTRODUCTION: Definition of robot, necessity, advantages and disadvantages of robots, basic components of a robotic systems, robot joints, degrees of freedom, configurations of robots – cartesian, cylindrical, spherical, articulated, SCARA, work volume, specification of a robot- load carrying capacity (pay load), reach, stroke, speed of motion, speed of response, stability, repeatability, resolution and Accuracy.
UNIT – II
DRIVES/ACTUATORS: Hydraulic, pneumatic and electrical. Stepper motors, brushless motors, servo motor, and comparison of drives.
ROBOT GRIPPERS: Types of end-effectors/grippers, mechanical grippers.
ROBOT SENSORS: Position, velocity, force, tactile, range, proximity sensors, machine vision - elements of machine vision.</td></tr>
</table>

	UNIT – III **ROBOT CLASSIFICATION:** Servo and non-servo controlled robots, limited sequence, Point to point, continuous and intelligent robots. **TRAJECTORY PLANNING:** Path vs trajectory, joint space and cartesian space schemes, basics of trajectory planning, Joint space trajectory including via points - cubic polynomials, cartesian straight-line trajectory. **UNIT – IV** **KINEMATIC ANALYSIS OF ROBOTS:** Homogeneous transformation matrices, inverse of transverse transformation, forward and inverse kinematics of robot, Singularity errors, DH matrix, HT of robot coordinate system, 2R and 3R robot manipulators. **DYNAMICS:** Introduction to robot dynamics. **UNIT – V** **ROBOT PROGRAMMING:** Importance, types, manual setup, lead through programming, textual programming languages, commands for elementary operations – RAPID – WAIT, DELAY, STOP, PAUSE, SIGNAL ON/OFF, ZONE, MOVE **UNIT – VI** **APPLICATIONS OF ROBOT:** Material handling, machine loading/unloading, assembly, inspection and processing. Robot work cells. Safety aspect and economic analysis. Need and application of AI in robotics
TEXT BOOKS:	1. Saeed B. Niku, Introduction to Robotics : Analysis, Systems, Applications, Pearson Education Inc., 2001 2. Industrial Robotics, Technology, Programming and Applications: Groover M.P., Weiss M.andOdrey N.G., McGraw Hill Higher Education, 2nd ed., 2012. 3. Robotics, Fundamental Concepts and analysis : Ashitave Ghosal, Oxford Press, 1st ed., 2006.
REFERENCES:	1. Robotics and Control :R.K.Mittal and I J. Nagarath, McGraw Hill, 2015 2. Robotics : Fu K S, R.C. Gonazalez and C.S.G Lee, McGraw Hill, 2008 3. Introduction to Robotics, Mechanics and Control: John J.Craig, Pearson Education, 3rd ed., 2009.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME32E2 - COMPOSITE MATERIALS

(Professional Elective-II)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 -0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Materials Science</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Explain the behavior of constituents in the composite materials.
2. Enlighten the students in different types of reinforcement.
3. Develop the student’s skills in understanding the different manufacturing methods available for composite material.
4. Illuminate the knowledge and analysis skills in applying basic laws in mechanics to the composite materials.
5. To know the industrial applications of composite materials.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Recall of information like, technical terms, classifications, categories, and criteria</td><td>K1</td></tr>
<tr><td>CO2</td><td>Explain the mechanical behavior of composites compared to isotropic materials</td><td>K2</td></tr>
<tr><td>CO3</td><td>Apply constitutive equations of composite materials and understand mechanical behavior at micro and macro levels.</td><td>K3</td></tr>
<tr><td>CO4</td><td>Determine stresses and strains relation in composites materials.</td><td>K4</td></tr>
<tr><td>CO5</td><td>Demonstrating correct usage of a method or procedure for producing different composites.</td><td>K2</td></tr>
<tr><td>CO6</td><td>Identify the industrial applications of composite materials in various fields.</td><td>K3</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
INTRODUCTION TO COMPOSITE MATERIALS: Introduction, Classification- Polymer Matrix Composites, Metal Matrix Composites, Ceramic Matrix Composites, Carbon–Carbon Composites, Fiber Reinforced Composites, and nature-made composites, advantages of composites.
UNIT – II
REINFORCEMENTS: Classification of Reinforcements- Fibers reinforcements, Glass Fibers, Boron Fibers, Carbon Fibers, Organic Fibers, Ceramic Fibers, Metallic Fibers, Comparison of Fibers. Particulate reinforcements, fabrication and properties.</td></tr>
</table>

	UNIT – III **Metal Matrix Composites:** Fabrication of MMCs-Solid State Fabrication, Liquid State Fabrication, In Situ Fabrication Techniques. Interface in Metal Matrix Composites- Mechanical Bonding, Chemical Bonding, Interfaces in Situ Composites. Discontinuous Reinforcement of MMCs. **UNIT – IV** **Polymer Matrix Composites:** Fabrication of PMCs, Autoclave, tape production, moulding methods, filament winding, manual layup, pultrusion, RTM. Properties of PMCs, Interface in PMCs. **Ceramic Matrix Composites:** Fabrication of CMCs, Properties of CMCs, Interface in CMCs, Toughness of CMCs. **UNIT – V** **Interfaces:** Wettability and Bonding, Types of Bonding, Interface in Composites, Interactions, Tests and measurement of Interfacial Strength. **Strength and stiffness of single layer fiber reinforced composite-** Voight's rule for volume and weight fraction, longitudinal strength and stiffness, transverse modules, in plain shear modules, poisons ratio. **UNIT – VI** **INDUSTRIAL APPLICATION OF COMPOSITE MATERIALS**: Civil constructions of structures/panels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold and sports components and case studies composite material applications.
TEXT BOOKS:	**1.** Composite materials - K.K. Chawla, 3rd ed., Springer, NewYork, 2012. 2. Mechanics of Composite Materials - R. M. Jones, 2nd ed., McGraw Hill, 1999. 3. Mechanics of composite materials and structures - Madhujit Mukhopadhyay, universities pres,2017.
REFERENCES:	1. Analysis and performance of fibre Composites - B. D. Agarwal, L.J. Broutman and K. Chandra shekhara, 3rd ed., John Wiley and Sons,New York, 2006. 2. Mechanics of Composite Materials (Mechanical Engineering) - Autar K. Kaw, London, 2nd ed., CRC Publication, Taylor &Francis group, 1993.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME32E3 - SUPPLY CHAIN MANAGEMENT

(Professional Elective-II)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3- 0 - 0
Prerequisite:	Industrial Engineering	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

The objectives of this course are to provide the student with:

1. An understanding of the primary differences between logistics and supply chain management
2. An understanding of the individual processes of supply chain management and their interrelationships within individual companies and across the supply chain
3. An understanding of the management components of supply chain management
4. An understanding of the tools and techniques useful in implementing supply chain management
5. Knowledge about the professional opportunities in supply chain management.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Understand fundamental supply chain management concepts	K2
CO2	Demonstrate an ability to engage in critical thinking by analyzing situations and constructing and selecting viable solutions to solve problems.	K2
CO3	Analyze the creation of new value in the supply chain for customers, society and the environment	K4
CO4	Understand the foundational role of logistics as it relates to transportation and warehousing	K2
CO5	Apply knowledge to evaluate and manage an effective supply chain	K3
CO6	Analyze and improve supply chain processes	K4

Course Content

UNIT – I

STRATEGIC FRAMEWORK: Introduction to supply chain management, decision phases in a supply chain, process views of a supply chain: push/pull and cycle views, achieving strategic fit, expanding strategic scope.

	UNIT – II **SUPPLY CHAIN DRIVERS AND METRICS:** Drivers of supply chain performance, framework for structuring drivers, obstacles to achieving strategic fit. **UNIT – III** **DESIGNING SUPPLY CHAIN NETWORK:** Factors influencing distribution network design, design options for a distribution network, E-business and distribution network, framework for network design decisions, models for facility location and capacity allocation. **UNIT – IV** **FORECASTING IN SUPPLY CHAIN:** Role of forecasting in a supply chain, components of a forecast and forecasting methods, risk management in forecasting. **UNIT – V** **AGGREGATE PLANNING AND INVENTORIES IN SUPPLY CHAIN:** Aggregate planning problem in supply chain, aggregate planning strategies, planning supply and demand in a supply chain, managing uncertainty in a supply chain: safety inventory. **UNIT – VI** **COORDINATION IN SUPPLY CHAIN:** Modes of transportation and their performance characteristics, supply chain IT framework, coordination in a supply chain and bullwhip effect.
TEXT BOOKS:	1.Sunil Chopra and Peter Meindl, Supply Chain Management - Strategy, Planning and Operation, 6th Edition, Pearson Education Asia, 2016. 2. David Simchi-Levi, PhilpKamintry & Edith Simchy Levy, Designing and Managing the Supply Chain-Concepts Strategies and Case Studies, Second Edition, Tata-McGraw Hill, 2000.
REFERENCES:	1. David Burt, Donald Dobler, Stephen Starling, World Class Supply Management: The Key to Supply Chain Management**,** McGraw Hill Education; 7th edition, 2017. 2. James stevens,Supply Chain Management: Strategy, Operation & Planning for Logistics Management, Create space Independent Publishers, 2016.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME32E4- ENERGY CONSERVATION AND MANAGEMENT
(Professional Elective-II)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 -0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Environmental Studies, Industrial Engineering & Management</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To provide detailed understanding of energy conservation and management
2. To understand the concept of 3Es (Energy, Economics and Environment) and their interaction
3. Explain about the Energy audit and financial management.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Understand the basic knowledge of different terms & principles of energy conservation, audit and management.</td><td>K2</td></tr>
<tr><td>CO2</td><td>Evaluate the energy saving & conservation in different mechanical utilities.</td><td>K4</td></tr>
<tr><td>CO3</td><td>Understand efficient heat & electricity utilization, saving and recovery in different thermal and electrical system.</td><td>K2</td></tr>
<tr><td>CO4</td><td>Prepare energy audit report for different energy conservation instances.</td><td>K4</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
Energy Scenario: Classification of Energy, Indian energy scenario, Sectorial energy consumption (domestic, industrial and other sectors), energy needs of growing economy, energy intensity, long term energy scenario, energy pricing, energy security, energy conservation and its importance, energy strategy for the future.

Energy Conservation Act 2001 and related policies: Energy conservation Act 2001 and its features, notifications under the Act, Schemes of Bureau of Energy Efficiency (BEE) including Designated consumers, State Designated Agencies, Electricity Act 2003, Integrated energy policy, National action plan on climate change, ECBC code for Building Construction.</td></tr>
</table>

	UNIT – II **Financial Management and Energy Monitoring and Targeting:** Investment-need, appraisal and criteria, financial analysis techniques simple payback period, return on investment, net present value, internal rate of return, cash flows, risk and sensitivity analysis; financing options, energy performance contracts and role of Energy Service Companies (ESCOs) . **Energy Monitoring and Targeting:** Defining monitoring & targeting, elements of monitoring & targeting, data and information-analysis, techniques – energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS). **UNIT – III** **Energy Management & Audit:** Definition, energy audit, need, types of energy audit. Energy management (audit) approach-understanding energy costs, Bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel and energy substitution, energy audit instruments and metering. **UNIT – IV** **Energy Efficiency in Thermal Utilities and systems:** **Boilers:** Types, combustion in boilers, performances evaluation, analysis of losses, feed water treatment, blow down, energy conservation opportunities. Boiler efficiency calculation, evaporation ratio and efficiency for coal, oil and gas. Soot blowing and soot deposit reduction, reasons for boiler tube failures, start up, shut down and preservation, Thermic fluid heaters, super critical boilers **Steam System:** Properties of steam, assessment of steam distribution losses, steam leakages, steam trapping, condensate and flash steam recovery system, identifying opportunities for energy savings. Steam utilization, Performance assessment more details, installation, thermo-compressor, steam pipe insulation, condensate pumping, steam dryers. **UNIT – V** **Furnaces:** Classification, general fuel economy measures in furnaces, excess air, heat distribution, temperature control, draft control, waste heat recovery. Forging furnace heat balance, Cupola, non-ferrous melting, Induction furnace, performance evaluation of a furnace, hot air generators. **Insulation and Refractories:** Insulation-types and application, economic thickness of insulation, heat savings and application criteria, Refractory-types, selection and application of refractories, heat loss. Cold insulation.

	UNIT – VI Energy and environment, air pollution, climate change: United Nations Framework Convention on Climate Change (UNFCC), sustainable development, Kyoto Protocol, Conference of Parties (COP), Clean Development Mechanism (CDM), CDM Procedures case of CDM – Bachat Lamp Yojna and industry; Prototype Carbon Fund (PCF).
TEXT BOOKS:	1. Energy Conservation Guidebook, Dale R Patrick, Stephen W Fardo, 2nd Edition, CRC Press 2. Handbook of Energy Audits, Albert Thumann, 6th Edition, The Fairmont Press. 3. Bureau of Energy Efficiency Reference book: No.1, 2, 3, 4
REFERENCES:	1. Energy Management Handbook, W.C. Turner, John Wiley and Sons, A Wiley Interscience publication 2. Carbon Capture and Sequestration: Integrating Technology, Monitoring, and Regulation edited byE J Wilson and D Gerard, Blackwell Publishing 3. Heating and Cooling of Buildings - Design for Efficiency, J. Krieder and A. Rabl, McGraw Hill Publication, 1994.
E-Resources:	**1. http://nptel.iitm.ac.in/** **2. www.bee.com** **3. www.powermin.nic.in** **4. www.teriin.org**

OPEN ELECTIVE-II

20ME32O1 - OPERATIONS RESEARCH
(Open Elective-II)

<table>
<tr><td>Course Category:</td><td>Open Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 -0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Engineering Mathematics, Matrices and Numerical Methods.</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To analyze linear programming models in practical and their practical use.
2. To apply the Transportation, Assignment and sequencing models and their solution methodology for solving problems
3. To apply the theory of games, Replacement, Inventory and Queuing models and their solution methodology for solving problems.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Understand the basic operations research concepts and terminology involved in optimization techniques</td><td>K2</td></tr>
<tr><td>CO2</td><td>Formulate a real-world problem as a mathematical programming model</td><td>K4</td></tr>
<tr><td>CO3</td><td>Understand how to model and solve problems using Simplex method for linear programming and perform iterations of it by hand</td><td>K2</td></tr>
<tr><td>CO4</td><td>Understand the importance and function of inventory and to be able to apply selected techniques for its control and management under dependent and independent demand circumstances.</td><td>K2</td></tr>
<tr><td>CO5</td><td>Evaluate the Problems using queuing theory</td><td>K4</td></tr>
<tr><td>CO6</td><td>Model a dynamic system as a queuing model and compute important performance measures</td><td>K3</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
LINEAR PROGRAMMING-1: Introduction to general nature of operations research models, types of OR models. Linear programming – Formulation, graphical method, simplex method, degeneracy in LPP.

UNIT – II
LINEAR PROGRAMMING-2: Artificial variable techniques – Big-M method, two-phase method. Dual simplex method.
GAME THEORY: Two-person zero-sum games, saddle point, algebraic and arithmetic methods (2x2 Games), principle of dominance, graphical method.</td></tr>
</table>

	UNIT – III **TRANSPORTATION PROBLEMS**: Formulation, different methods of obtaining initial basic feasible solution – North-West corner rule, least cost method, Vogel's approximation method. Optimal solution for transportation problem. Special cases – Unbalanced transportation problem. **ASSIGNMENT PROBLEMS**: Formulation, balanced assignment problem, unbalanced assignment problem. Travelling salesman problem. **UNIT – IV** **REPLACEMENT MODELS:** Replacement of items that deteriorate with time – with and without change in money value, group replacement of items that fail suddenly. **SEQUENCING MODELS**: n jobs-two machines, n jobs-m machines and 2 jobs-m machines. **UNIT – V** **INVENTORY MODELS:** Costs used in inventory models, basic inventory models without shortages. Quantity discounts (price breaks)-Purchasing models with one price and two price breaks. Single period models with probabilistic demand and without set up cost. ABC and VED analysis. **UNIT – VI** **QUEUING THEORY:** Basic structure of queuing models, single-server and multi-server models. Finite and Infinite applications. **PROJECT MANAGEMENT**: Introduction, construction rules of drawing, Fulkerson's rule, Critical path method (CPM) - critical path and project duration. PERT – Introduction, different time estimates, expected time, variance, expected project duration and probability of completion.
TEXT BOOKS:	1. Introduction to Operations Research: Hamdy A Taha, Prentice Hall, 10th ed., 2017 2. Introduction to Operations Research : S.D. Sharma, KedarNath, Ram Nath and Co., 2002 3. Introduction to Operations Research : D.S Hira and P. K. Gupta, S. Chand, 7th Revised., 2014
REFERENCES:	1. Introduction to Operations Research: Hillier and Lieberman, McGraw-Hill, 10th ed., 2018 2. Operations Research: Panneerselvam R., 2nd ed., PHI, 2011
E-Resources:	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME32O2 DESIGN OF EXPERIMENTS
(Open Elective-II)

<table>
<tr><td>Course Category:</td><td>Open Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture – Tutorial – Practical:</td><td>3-0-0</td></tr>
<tr><td>Pre-requisite:</td><td></td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">• Explain basic principles of design of experiments.
• Develop factorial and fractional factorial designs for product and process optimization.
• Design and conduct orthogonal array experiments for process improvement.
• Illustrate robust design concepts.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon the successful completion of the course, the students will be able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Recall the basic terms as used and applied in the context of design of experiments</td><td>K1</td></tr>
<tr><td>CO2</td><td>Understand the process of developing strategic plans for experimentation in scientific and engineering research projects.</td><td>K2</td></tr>
<tr><td>CO3</td><td>Apply the principles of DoE to generate experimental designs.</td><td>K3</td></tr>
<tr><td>CO4</td><td>Analyze alternative designs for experimentation and carry out output analysis for quality improvement projects.</td><td>K4</td></tr>
<tr><td>CO5</td><td>Evaluate the performance of the research investigations based on factorial and fractional factorial designs.</td><td>K4</td></tr>
<tr><td>CO6</td><td>Create experimental designs for product and process quality improvement projects for various scientific and engineering applications.</td><td>K4</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT-I
Introduction: Strategy of experimentation, applications, Basic principles, Terminology, Guidelines, History of statistical design.
Principles of quality engineering - Tools used in robust design, Applications and benefits, Quality loss function, Quadratic loss function, Noise factors, P diagram, Optimization of product & process design, Role of various quality control activities.

UNIT-II
Factorial Experimentation- The 2^2 design, The 2^3 design, The general 2^k design, A single replicate of the 2^k design, The 3^2 design. Problems.</td></tr>
</table>

	UNIT-III Blocking and Confounding in the 2^k Factorial Design: Blocking a replicated 2^k factorial design, Confounding in the 2^k factorial design, Confounding the 2^k factorial design in 2 & 4 blocks. Problems. Fractional **UNIT-IV** Factorial Designs: The one – half fraction & one – quarter fraction of the 2^k design, Resolution III, IV & V designs. Problems. **UNIT-V** **Constructing Orthogonal Arrays:** Counting degrees or freedom, selecting a standard orthogonal array, dummy level technique, and compound factor method. Linear graphs and interaction assignment, modification of linear graphs, column merging method, branching design. Strategy for constructing an orthogonal array. Problems. Grey Taguchi Method. **UNIT-VI** . **Steps In Robust Design:** Case study discussion illustrating steps in Robust Design. **Signal-To-Noise Ratio:** Evaluation of sensitivity to noise. S/N ratios for static problems, S/N ratios for dynamic problems. Analysis of ordered categorical data. Minimizing variability and optimizing averages. Taguchi Inner and Outer Arrays. Software packages for design of Experiments.
TEXT BOOKS:	1. D.C. Montgomery, Design and Analysis of Experiments, Wiley India, 5th Edition, 2006, ISBN – 812651048-X. 2. Madhav S. Phadke, Quality Engineering Using Robust Design, Prentice Hall PTR, Englewood Cliffs, New Jersey 07632,1989, ISBN: 0137451679.
REFERENCES:	1. Robert H. Lochner, Joseph E. Matar, Designing for Quality - an Introduction Best of Taghuchi and Western Methods or Statistical Experimental Design, Chapman and Hall, 1990, ISBN – 0412400200 2. Philip J. Ross, Taguchi Techniques for Quality Engineering: Loss Function, Orthogonal Experiments, Parameter and Tolerance Design, McGraw-Hill, 2nd Edition, 1996, ISBN:0070539588
e-Resources:	**https://nptel.ac.in/courses/111104075**

20ME32O3-WORK STUDY

(Open Elective-II)

<table>
<tr><td>Course Category:</td><td>Open Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 - 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Mathematics, Statistics</td><td>Sessional Evaluation :
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To optimize the use of plant, equipment, manpower and material
2. To develop efficient work methods.
3. To improve productivity.
4. To determine the standard time and apply work measurement techniques
5. To understand techniques of job evaluation, merit rating and ergonomics.</td></tr>
<tr><td rowspan="8">Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:</td></tr>
<tr><td>CO</td><td>Course Outcomes</td><td>Knowledge Level</td></tr>
<tr><td>CO1</td><td>Analyze and redesign processes for improved efficiency and effectiveness, using best practices and work-study techniques.</td><td>K4</td></tr>
<tr><td>CO2</td><td>Determine the number of staff required in a unit or function using the techniques of work-study mathematics.</td><td>K4</td></tr>
<tr><td>CO3</td><td>Understand the critical linkage between process and organization design.</td><td>K2</td></tr>
<tr><td>CO4</td><td>Apply modern organizational models and team-based structures to redesign an organization for improved effectiveness and decision making.</td><td>K3</td></tr>
<tr><td>CO5</td><td>Interpret decision-making models with organization and job design.</td><td>K2</td></tr>
<tr><td></td><td>CO6</td><td>understand techniques of job evaluation, merit rating and ergonomics</td><td>K2</td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I

INTRODUCTION TO WORK STUDY- Scientific management- Productivity. Advantages of work study- work study and workers – work study and management</td></tr>
</table>

	UNIT – II **METHOD STUDY**: Introduction- Significance of process charts. Critical Examination- Identification of key activities of exercises on process charts - Flow diagrams - String diagrams – travel chart. **UNIT – III** **MICRO MOTION ANALYSIS**- Memo motion films, Therbligs. Principles of Motion Economy: Work place layout, Human body, Design of tools and equipment. **UNIT – IV** **Work Measurement :** Introduction, Techniques of W.M., objectives and uses of Time study, Time Study Equipment's, Procedure for Time study, Selection of Job for T.S. , Selection of Operator Recording of Information, Breaking operation in to elements, Choice of Elements, Number of readings, Procedure of using and its methods, Training in Rating, Allowances and types, Calculation of standard Time. **UNIT-V** **Other Methods of Work Measurement:** Synthesis, standard data, Production interruption study, analytical estimation, work sampling, statistical concepts, confidence limits, number of observations, P.M.T.S., M.T.M., W.F.S. Industrial visits to be organized to understand the above topics practically, and assessment of the study during visit will carry weightage in Theory and Practical exams **UNIT - VI** **JOB EVALUATION**- Techniques of job evaluation. Merit rating, Fatigue, Ergonomics, Ergonomics applied to work place layout.
TEXT BOOKS:	1. Introduction to Work Study: 4th ed., Indian Labour Organization, 1992 2. Elements of Work Study and Ergonomics : Dalela Etal, Standard Publications, 1990
REFERENCES:	1. Motion and Time Study – Design and Measurement of Work : R.M. Barnes, Wiley, 1968 2. Work Study : Khanna O.P Khanna publications, 2010
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME32P1 - HEAT TRANSFER LABORATORY

<table>
<tr><td>Course Category:</td><td>Program Core</td><td>Credits:</td><td>1.5</td></tr>
<tr><td>Course Type:</td><td>Practical</td><td>Lecture - Tutorial - Practical:</td><td>0 - 0 - 3</td></tr>
<tr><td>Prerequisite:</td><td>Heat Transfer</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To experimentally determine thermal conductivity of various materials
2. To experimentally measure heat transfer coefficients of forced and natural convection
3. To experimentally measure emissivity of grey surface
4. To experimentally measure effectiveness of heat exchangers
5. To conduct performance tests on refrigeration & air conditioning systems</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr>
<tr><td>CO1</td><td>Know the concepts discussed in the Heat Transfer course.</td><td>K5</td></tr>
<tr><td>CO2</td><td>Conduct various experiments to determine thermal conductivity of various materials.</td><td>K5</td></tr>
<tr><td>CO3</td><td>Determine heat transfer coefficients of forced and natural convection</td><td>K5</td></tr>
<tr><td>CO4</td><td>Conduct performance tests and thereby improve effectiveness of heat exchangers</td><td>K5</td></tr>
<tr><td>CO5</td><td>Conduct performance tests and thereby improve performance of refrigeration and air conditioning systems</td><td>K5</td></tr>
<tr><td>CO6</td><td>Investigate the emissivity of grey surface</td><td>K4</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">List of Experiments:
1. Test on Conduction in Composite Wall.
2. Test on Emissivity Measurement Apparatus.
3. Test on Lagged Pipe Apparatus.
4. Test on Stefan-Boltzmann Apparatus.
5. Test on Natural Convection Apparatus.
6. Test on Forced Convection Apparatus.
7. Test on Drop-wise Condensation Apparatus.
8. Test on Vapour Compression Refrigeration System.
9. Test on Air-Conditioning Test Rig.
10. Test on thermal conductivity of insulating powder
11. Test on pin fin apparatus
12. Test on critical heat flux
13. Test on heat pipe apparatus
14. Test on Thermal Conductivity of a Metal Rod.</td></tr>
</table>

20ME32P2-DYNAMICS AND VIBRATION LABORATORY

Course Category:	Program core	**Credits:**	1.5
Course Type:	Practical	**Lecture - Tutorial - Practical:**	0 - 0 - 3
Prerequisite:	TOM-I & TOM-II	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To study the vibration analysis of spring-mass system.
2. To study the gyroscopic effect of the given gyroscope for constant speed and load conditions.
3. To study equilibrium speed of different governors.
4. To give understanding CAM and balancing of machinery.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Inspect the critical speed of shaft under the given load conditions and the gyroscopic effect and couple on motorized gyroscope.	K4
CO2	Examine the balancing of reciprocating and rotating masses in dynamic balancing machine.	K5
CO3	Sketch the characteristic curves of Watt, Porter, Proell and Hartnell governors.	K3
CO4	Analysis of CAM and MATLAB coding for dynamic response of spring mass system.	K4

Course Content

List of Experiments:

1. Test on gyroscopic unit.
2. Test on critical speed analyzer.
3. Test on vibration test rig.
4. Study balancing of reciprocating masses
5. Study on balancing of rotating masses
6. Test on Proell Governors
7. Test on Porter Governors
8. Test on Hartung Governors
9. Study on reciprocating mechanism.
10. Test on CAM apparatus
11. Study on crank and slotted mechanism
12. Estimation of CG of connecting rod using Trifilar system

20ME32P3- ENGINEERING METROLOGY& INSTRUMENTATION LABORATORY

<table>
<tr><td>Course Category:</td><td>Program core</td><td>Credits:</td><td>1.5</td></tr>
<tr><td>Course Type:</td><td>Practical</td><td>Lecture - Tutorial - Practical:</td><td>0-0-3</td></tr>
<tr><td>Prerequisite:</td><td>Engineering Metrology& Instrumentation</td><td>Sessional Evaluation :
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To learn the Measurement of linear and angular dimensions.
2. To learn the calibration measures of Metrology instruments.
3. To understand the Measuring procedures of Straightness and flatness.
4. To learn the Measurement of Miniature and fragile parts.
5. To learn the Measurement of pressure, flow and temperature.
6. To learn the Miscellaneous Measurement procedures of machined parts</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table><tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Level</th></tr><tr><td>CO1</td><td>Calibrate the linear dimensions of different mechanical components.</td><td>K6</td></tr><tr><td>CO2</td><td>Calibrate the angular dimensions of different mechanical components</td><td>K6</td></tr><tr><td>CO3</td><td>Calibrate the errors in surface flatness and straightness.</td><td>K6</td></tr><tr><td>CO4</td><td>Measure the straightness and flatness of engineering surfaces.</td><td>K5</td></tr><tr><td>CO5</td><td>Measure Pressure, Temperature and Flow in practical applications.</td><td>K5</td></tr><tr><td>CO6</td><td>Describe the measuring procedures of Strain, Torque for practical applications.</td><td>K2</td></tr></table></td></tr>
<tr><td>Course Content</td><td colspan="3">List of Experiments:
Metrology Lab
1. Calibration of any two of the following instruments: (using slip gauges)
(i) Calibration of Micrometer. (ii) Calibration of Mechanical Comparator.
(iii) Calibration of Vernier Calipers (iv) Calibration of Dial Gauge.
2. Measurement of taper angle using
(i) Bevel Protractor (ii) Dial Gauge (iii) Sine-Bar (iv) Auto-Collimator.
3. Gear testing:
To find;
(i) diameter, pitch/module (ii)pitch circle diameter</td></tr>
</table>

	(iii) pressure angle (iv)tooth thickness. 4. Check the straightness of a surface plate (i) Using spirit level (ii) Using Auto-collimator 5. Check the flatness of a surface plate using one of the above methods. 6. Tool Maker's Microscope: i. Establish the thread details ii. To find the cutting tool angles. 7. Miscellaneous: i. To find the diameter of a cylindrical piece ii. Taper angle of a V-block iii. Central distance of two holes of a specimen. **Instrumentation Lab** 1. Strain Measurement. 2. Pressure Measurement. 3. Temperature Measurement. 4. Torque Measurement. 5. Temperature Control. 6. Pressure Control. 7. Flow Control.

20ME32SC ROBOTICS SIMULATION

Course Category:	Skill Advanced Course	**Credits:**	2
Course Type:	Practical	**Lecture - Tutorial - Practical:**	0-0-4
Prerequisite:	Robotics	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To develop the student's knowledge in various robot structures and their workspace.
2. To develop student's skills in writing program for industrial robot
3. To develop simulation using the Robostudio
4. To provide the student with knowledge of microcontrollers and drives
5. To provide the student with some knowledge and analysis skills associated with controlling

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Level
CO1	Design the industrial robotic work cell	K6
CO2	Define Path of the industrial robot	K5
CO3	Generate Program for operation	K6
CO4	Simulate Graphically & Verify the robotic work cell	K6
CO5	Develop various robot structures	K6
CO6	Develop knowledge of microcontrollers and drives	K6

Course Content

List of Experiments:

1. Study on Industrial robot coordinate systems
2. Generation of TCP and Work object coordinates
3. Write programs on creating and defining the path target of the industrial ROBOT
4. To perform the Robot programming exercise for Pick and Place operation using teach pendent.
5. Study and selection of Gripper.
6. Write a rapid program for Linear Movements, Non Linear Movements using robostudio
7. Create a mechanism in Robostudio simulation software
8. Create an Auto path in Robostudio simulation software
9. Jogging the robot using teach pendent for different modes
10. Development of mechanism for orientation and position of the object
11. Simulation of work cell for loading and unloading applications
12. Simulation of workcell for welding applications
13. Simulation of assembly operation peg in hole
14. Simulation of inspection applications

20MC3201-ENTREPRENEURSHIP

Course Category:	**Mandatory Course**	**Credits:**	0
Course Type:	**Theory**	**Lecture - Tutorial - Practical:**	2 -0- 0
Prerequisite:	**General Business awareness**	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives	The students develop and can systematically apply an entrepreneurial way of thinking that will allow them to identify and create business opportunities that may be commercialized successfully.		
Course Outcomes	Upon successful completion of the course , the students will able to:		
	CO	**Course Outcomes**	**Knowledge Level**
	CO1	Understand/ Overview of Entrepreneurship	K2
	CO2	Know the methods of generating ideas	K3
	CO3	Understand the concept of Business planning	K2
	CO4	Understand managing the new venture	K2
	CO5	Know the production and marketing management	K3
	CO6	Know the financial assistance to Enterprise	K3

Course Content

UNIT – I

Introduction to Entrepreneurship: Definition of Entrepreneur, Entrepreneurial Traits, Entrepreneur vs. Manager, Entrepreneur vs Intrapreneur, Opportunities for Entrepreneurs in India and abroad, Woman as Entrepreneur, Role of Entrepreneurship in economic development.

UNIT – II

Creating the Ideas and Starting the Venture: Sources of new Ideas, Methods of generating ideas, creating problem solving. Features and evaluation of joint ventures, acquisitions, merges, franchising, Public issues, rights issues, and bonus issue sand stock splits.

UNIT – III

Business planning process: Meaning of business plan, Business plan process- Writing ,evaluation and implementation of business plan , advantages of business planning , Business model canvas

UNIT – IV

Managing the new venture: Sources of capital, venture capital, Record keeping, recruitment, motivating and leading teams,

	UNIT – V **Production & Marketing management**: Thrust of production management, selection of production techniques, Marketing functions, market segmentation, market research. **UNIT – VI** **Organization Assistance:** Industrial Park (Meaning, features, & examples),Special Economic Zone (Meaning, features & examples), Financial assistance by different agencies (SIDBI, DIC , NSTEDB, APPC etc.), MSME Act Small Scale Industries,
Assignment	**All students (Maximum batch size 5) need to submit a business plan on any entity as per the norms of any financial agency**
TEXT BOOKS:	1. Entrepreneurship : Robert Hisrich, & Michael Peters, 5th ed., TMH., 1986 2. Entrepreneurship : Dollinger, Pearson, 4th ed., 2004.
REFERENCES:	1. Dynamics of Entrepreneurial Development and Management, Vasant, 2009. 2. Harvard Business Review on Entrepreneurship. HBR Paper Back, 1999. 3. Entrepreneurial Management, Robert J.Calvin, TMH, 2004. 4. Essential of Entrepreneurship and small business management, Thomas W. Zimmerer& Norman M. Scarborough, 4th ed., PHI, 2005 5. Industrial Relations &Labour Laws, Srivastava, Vikas, 2005.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

N.B.K.R. INSTITUTE OF SCIENCE & TECHNOLOGY

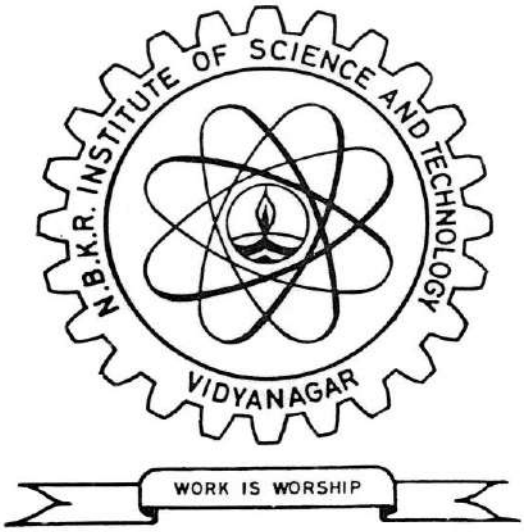
(AUTONOMOUS)

COLLEGE WITH POTENTIAL FOR EXCELLENCE (CPE)

Affiliated to JNTUA, Ananthapuramu

Re-Accredited by NAAC with 'A' Grade

B.Tech. Courses Accredited by NBA under TIER-I



SYLLABUS

B.TECH. DEGREE COURSE

IV B.TECH

I & II Semesters

MECHANICAL ENGINEERING

(With effect from the batch admitted in the academic year 2020-2021)

VIDYANAGAR - 524413
SPSR Nellore-Dist. Andhra Pradesh
www.nbkrist.org

INSTITUTE VISION

To emerge as a comprehensive Institute that provides quality technical education and research thereby building up a precious human resource for the industry and society.

INSTITUTE MISSION

- To provide a learner-centered environment that challenges individuals to actively participate in the education process.

- To empower the faculty to excel in teaching while engaging in research, creativity and public service.

- To develop effective learning skills enabling students pick up critical thinking thus crafting them professionally fit and ethically strong.

- To share human and academic resources with industries, schools and public agencies through partnerships and outreach activities.

VISION OF THE DEPARTMENT

To become an excellent centre for technical education and research in the field of mechanical engineering to meet the societal, regional, national and global challenges.

MISSION OF THE DEPARTMENT

M1: To impart quality technical education and transform bud engineers into an effective and responsible engineers to work with the current technologies in multi-cultural and multi-discipline environment.

M2: To encourage the students to develop their creativity in the field of mechanical engineering by providing modern laboratory facilities with hands on training and contemporary curriculum.

M3: To develop the interaction with the Industry experts to gain practical knowledge.

M4: To provide best teaching & learning practices as well as creating opportunities for Research, maximise student results and placements.

M5: To inculcate and promote lifelong learning skills, problem solving skills, leadership qualities and team work.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO 1: A strong foundation to access, analyze, plan and implement their knowledge in basic sciences & mathematics, core and interdisciplinary courses.

PEO 2: Graduate will be in a position to work with the members of multi-disciplinary teams and can play a leading role in handling the technical issues.

PEO 3: Graduates will have capability to work with modern engineering tools, software and equipment under the realistic constraints.

PEO 4: Graduates will engage in lifelong learning skills with research attitude and social responsibility.

PROGRAM OUTCOMES(POs)

PO1 **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and engineering specialization to the solution of complex engineering problems.

PO2 **Problem analysis:** Identify, formulate, review the research literature, and analyze engineering problems to arrive at substantiated conclusions using first principles of mathematics, natural, and engineering sciences.

PO3 **Design/development of solutions:** Design solutions for complex engineering problems and design system components, processes to meet the specifications with consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 **Conduct investigations of complex problems:** Use research-based knowledge including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5 **Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6 **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO7 **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO9 **Individual and team work:** Function effectively as an individual, and as a member or leader in teams, and in multidisciplinary settings.

PO10 **Communication:** Communicate effectively with the engineering community and with society at large. Be able to comprehend and write effective reports documentation. Make effective presentations, and give and receive clear instructions.

PO11 **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.

PO12 **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.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1 Solve engineering problems in the area of Robotics and Automation.

PSO2 Design, Simulate and Analyze using CAD/CAM/CAE tools.

B Tech **R20 Regulations**

N B K R Institute of Science & Technology:: Vidyanagar

MECHANICAL ENGINEERING Course Structure (R20) – IV Year

IVB.Tech

Semester -VII						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1	20ME41E1	Professional Elective-III	3	0	0	3
2	20ME41E2	Professional Elective-IV	3	0	0	3
3	20ME41E3	Professional Elective-V	3	0	0	3
4	20ME41O1	Open Elective-III	3	0	0	3
5	20ME41O2	Open Elective-IV	3	0	0	3
6	20SH41O1	S&H Elective**(Statistical Methods)**	3	0	0	3
Skill Advanced Course-III						
7	20ME41SC	CAE/CAM Laboratory	1	0	2	2
Internship						
8	20ME41IN	Evaluation of Industry Internship				3
					Total	**23**

S.No	**Professional Elective -III**	**Professional Elective -IV**	**Professional Elective -V**
1.	Tool Design	Refrigeration &Air Conditioning	Finite Elements Method
2.	Process Planning and Cost Estimation	Cryogenic Engineering	Gas Dynamics and Jet Propulsion
3.	Production Systems	Power Plant Engineering	Turbo Machinery
4.	Metal Forming Technology	IC Engines	Computational Fluid Dynamics
5.	MOOCS (NPTEL/SWAYAM) Course (12 Weeks Duration)	MOOCS (NPTEL/SWAYAM) Course (12 Weeks Duration)	MOOCS (NPTEL/SWAYAM) Course (12 Weeks Duration)

S.No	**OPEN ELECTIVE – III**	**OPEN ELECTIVE - IV**
1	Autotronics	Internet of Things
2	Solar Energy Engineering	Design and Analysis of Algorithms
3	Mechatronics	Product Life Cycle Management

Semester -VIII						
S.No	**Course Code**	**Course Name**	**L**	**T**	**P**	**Credits**
1	20ME42PR	Internship & Project Work	-	-	-	12
					Total	**12**

PROFESSIONAL ELECTIVE-III

20ME41E1-TOOL DESIGN

(Professional Elective-III)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 - 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>CAMD, DME-I & DME-II</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Understand the tool signature and mechanics of metal cutting.
2. Understand the tool wear and damage in usageand identify the need of cutting fluids.
3. Recognize the properties desired for cutting tool materials and design of cutting tools.
4. Realize the costs associated with machining operations. Understand the mechanics of press working and identify the accessories required.
5. Understand the need of Jigs and fixtures. Recognize their principal parts.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table><tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr><tr><td>CO1</td><td>Calculate the values of various forces involved int he machining operations.</td><td>K4</td></tr><tr><td>CO2</td><td>Design various single and multipoint cutting tools.</td><td>K4</td></tr><tr><td>CO3</td><td>Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish.</td><td>K2</td></tr><tr><td>CO4</td><td>Analyze economics of machining operations.</td><td>K4</td></tr><tr><td>CO5</td><td>Identify press tool requirements to build concepts pertaining to design of press tools.</td><td>K3</td></tr><tr><td>CO6</td><td>Demonstrate various press working operations for mass production of sheet metal parts.</td><td>K2</td></tr></table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
METAL CUTTING TOOLS: Classification, nomenclature of single point cutting tool, difference between orthogonal and oblique cutting, mechanism of metal cutting, types of chips, chip breakers, velocity relations, forces acting on a tool, Merchant circle diagram, specific energy in cutting.</td></tr>
</table>

	UNIT – II **TOOL WEAR &TOOL LIFE**: Factors affecting tool life, Taylor's tool life equation. tool wear mechanisms, types of tool wear, machinabilty, heat distribution in metal cutting, measurement of temperature in metal cutting. Force measurement - lathe tool dynamometer. Selection and applications of cutting fluids **UNIT – III** **CUTTING TOOL MATERIALS**: Requirements of tool materials, advances in tool materials, HSS, Coated HSS, Carbides, Coated Carbides, Ceramics, Ceramic Composites, CBN and Diamond properties, advantages and limitations, specifications for inserts and tool holders. **UNIT – IV** **ECONOMICS OF MACHINING:** Costs associated with machining opera **DESIGN OF CUTTING TOOLS**: Design of single point cutting tool shanks, design of plane milling cutter and broaching tool. **UNIT – V** **PRESS WORKING:** Press working operations, press selection and tonnage, centre of pressure, cutting forces and clearances for die design, compound and progressive die, strip layout. **UNIT – VI** **JIGS & FIXTURES** - Uses, Locating devices, 3-2-1 principle of location, pin location, radial location, 'V' location, diamond locators. Types of clamping devices, principles of clamping. Design principles of jigs & fixtures, types of drill jigs, types of drill bushes, fixtures for turning.
TEXT BOOKS:	1. Fundamental of Tool Design: ASTME, PHI, 2010 2. A Text Book of Production Engineering: P.C. Sharma, S. Chand& Co. 11th ed., 2005 3. Fundamental of Metal Cutting and Machine Tools: B.L.Juneja and G.S.Sekhon, 2nded.,New Age International 2017.
REFERENCES:	1. Metal Cutting Principles: Milton C.Shaw, Oxford University Press, 2012. 2. Introduction to Jig and Fixture Design: Kempster, Hodder and StoughtonPublishers, 2004 3. Metal cutting (Theory and Practice): A. Bhattacharya, New central book Agency, 2012. 4. Tool Design : Donaldson, Tata Mc Graw Hill, 3rd ed., 2010
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME41E2-PROCESS PLANNING AND COST ESTIMATION

(Professional Elective-III)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 - 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Industrial Engineering and Management</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Understand the basic concepts of process Planning and estimation
2. Apply different methods of cost estimation in different manufacturing shops
3. Learn the concepts of process planning and cost estimation in competitive manufacturing systems and organizations.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon the completion of this course the students will be able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Select the process, equipment and tools for various industrial products.</td><td>K3</td></tr>
<tr><td>CO2</td><td>Prepare process planning activity chart.</td><td>K4</td></tr>
<tr><td>CO3</td><td>Explain the concept of cost estimation.</td><td>K2</td></tr>
<tr><td>CO4</td><td>Compute the job order cost for different type of shop floor.</td><td>K4</td></tr>
<tr><td>CO5</td><td>Calculate the machining time for various machining operations.</td><td>K4</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I

INTRODUCTION TO PROCESS PLANNING
Introduction- methods of process planning-Drawing interpretation - Material evaluation – steps in process selection-Production equipment and tooling selection
UNIT – II

PROCESS PLANNING ACTIVITIES
Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning-case studies
UNIT – III

INTRODUCTION TO COST ESTIMATION
Importance of costing and estimation –methods of costing-elements of cost estimation –Types of estimates – Estimating procedure-Estimation labor cost, material cost- allocation of overhead charges-Calculation of depreciation cost.</td></tr>
</table>

	UNIT – IV **PRODUCTION COST ESTIMATION IN WELDING & SHEET METAL SHOP** Estimation in welding shop - gas welding cost, arc welding cost - production cost of given welding job- the types of welding costs- the factors affecting the welding cost. Estimation in sheet metal shop - Sheet material and gauge number, Sheet metal joints - Estimate the material required for preparation of container open on one side, Cylindrical drum, funnel and tray. **UNIT-V** **PRODUCTION COST ESTIMATION IN FORGING SHOP & FOUNDARY SHOP** Cost terminology associated with forging shop- The procedure for calculating material cost of a product for forging shop- Procedure for estimating forging cost- forging losses to be considered while estimating -Estimation of forging cost. Estimation in foundry shop- pattern allowances- The procedure for calculating material cost of a product for foundry shop - Procedure for estimating cost of pattern making. -Procedure for estimating foundry cost of components such as C.I pulley and C.I. Wheel and estimate foundry cost. **UNIT – VI** **MACHINING TIME CALCULATION** Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations, Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning -Machining Time Calculation for Grinding.
TEXT BOOKS:	1. Peter scalon, "Process planning, Design/Manufacture Interface", Elsevier science technology Books, Dec 2002. 2. Sinha B.P, "Mechanical Estimating and Costing", Tata-McGraw Hill publishing co, 1995. 3.Mechanical estimation and costing T.R.Banga and S.C.Sharma, Khanna publishers. 4.M.Adithan, Process planning & cost estimation, New age International
REFERENCES:	1. Chitale A.V. and Gupta R.C., "Product Design and Manufacturing", 2nd Edition, PHI, 2002. 2. Ostwalal P.F. and Munez J., "Manufacturing Processes and systems", 9th Edition, John Wiley, 1998. 3. Russell R.S and Tailor B.W, "Operations Management", 4th Edition, PHI, 2003. 4. Mikell P. Groover, "Automation, Production, Systems and Computer Integrated Manufacturing", Pearson Education 2001.
E-Resources	**1. https://nptel.ac.in/courses/** **2.http://calculatoredge.com/index.htm#mechanical**

20ME41E3-PRODUCTION SYSTEMS

(Professional Elective-III)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 - 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Industrial Engineering andManagement</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Provide framework for understanding production and operations management.
2. To develop an understanding of operations management principle.
3. Equip plan and control activities necessary to run the operations.
4. Theoretical understanding to underpin operational decisions at tactical and strategic level.
5. Learn and develop critical understanding of techniques used within the operations managementlike planning, control, problem-solving and communication</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Understand the outline and fundamentals of the production systems</td><td>K2</td></tr>
<tr><td>CO2</td><td>Solve routing and scheduling problems</td><td>K4</td></tr>
<tr><td>CO3</td><td>Recognize the importance of facility location models</td><td>K2</td></tr>
<tr><td>CO4</td><td>Solve operational problems in the areas of aggregate production planning.</td><td>K4</td></tr>
<tr><td>CO5</td><td>Apply the principles and techniques for planning and control of the production and</td><td>K3</td></tr>
<tr><td>CO6</td><td>Summarize various aggregate production planning techniques.</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
PRODUCTION
Systems concept of production, types of Production – Continuous production(mass production, process production and assembly lines) and Intermittent production (job type andbatch type), Lean and Agile Manufacturing, Just-in-time (JIT), KANBAN systems.

UNIT – II
PRODUCTIVITY
Introduction, types of productivity, factors affecting productivity, techniquesfor improving productivity.
PRODUCT DESIGN AND ANALYSIS
Introduction, steps of product design, process planningand design, responsibilities of process planning engineer, steps in process planning.</td></tr>
</table>

	UNIT – III **SINGLE FACILITY LOCATION MODEL** Rectilinear minimum, Rectilinear minimax,Squared Euclidean distance location problem and Euclidean distance location problem. **MULTI FACILITY LOCATION MODEL** Squared Euclidean distance location problem.Travel chart and REL chart. **UNIT – IV** **ASSEMBLY LINE BALANCING:** RPW method, COMSOAL method. **MATERIALS REQUIREMENT PLANNING** Introduction, Lot sizing in MRP – EOQ method, minimum cost per period method, period order quantity method, least unit cost method and partperiod balancing method. MRP–II. **UNIT – V** **VALUE ANALYSIS** Types of values, aim of value analysis, technique and procedure of value analysis, and advantages. **AGGREGATE PLANNING** Introduction, Aggregate Planning Strategies – varying work force,changing inventory level and subcontracting. Transportation model for Aggregate planning. **UNIT – VI** **PROJECT MANAGEMENT** Introduction, construction rules of drawing, Fulkerson's rule, Critical path method (CPM) – floats, critical path, and project duration. PERT – Introduction, different time estimates, expected time, variance, expected project duration and probability of completion.
TEXT BOOKS:	1. Production and Operations Management : R. Panneerselvam, PHI Publications, 2012 2. Production Planning and Inventory Control :Seetharama L. Narasimhan, PHIPublications, 2nd ed., 2003.
REFERENCES:	1. Analysis and Control of Production Systems : Elsayed A., Thomas O. Boucher, PHI, 1985 2. Modern Production / Operations Management: Buffa and Sarin, 8th ed., John Wiley & sons,2007
E-Resources	**https://nptel.ac.in/courses**

20ME41E4- METAL FORMING TECHNOLOGY
(Professional Elective-III)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3 -0 - 0
Prerequisite:	Basic Manufacturing Process	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1.Understand the overview and fundamentals metal forming
2.Understand the fundamentals of rolling
3.Understand the fundamentals of extrusion and types of extrusion
4.Understand the fundamentals of forging and types of forging
5. Understand the fundamentals of high energy rate forming process.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Levels
CO1	Determine major process/processes of manufacturing used for given application.	K4
CO2	Explain when and why metal forming is chosen compared to other compatible methods.	K2
CO3	Analyze effect of parameters influencing metal forming and compare hot working and cold working with applications.	K4
CO4	Explain capabilities and applications of bulk metal forming processes and sheet metal work.	K2
CO5	Outline tooling and equipment required for important metal forming processes.	K2
CO6	Examine effects of friction & lubrication and causes of common defects in metal forming.	K4

Course Content

UNIT – I

THEORETICAL BASIS FOR METAL FORMING

Engineering stress-strain curve, true stress-strain curve, general state of stress at a point, yielding under complex stresses. Flow rules: levy-mises equations and Prandtl - Reuss equations. Strain hardening, recovery, recrystallisation and grain growth. Hot working, cold working and warm working. Comparison of properties of cold and hot worked parts, methods used in forming.

UNIT – II

ROLLING

Principles and theory of rolling, types of rolling mills and products. Forces in rolling and power requirements, process variables in rolling, roll camber, defects in rolled products, automatic gauge control.

	UNIT – III **FORGING PROCESSES** Principles of forging, types of forging – smith forging, drop forging, press forging, roll forging. Forging hammers, analysis of plane strain forging,forging defects. **UNIT – IV** **WIRE DRAWING** Wire drawing die, preparation of wire, lubrication, wire drawing bench. Tube drawing processes. **EXTRUSION PROCESSES** Basic extrusion process and its characteristics. Forward extrusion and backward extrusion, impact extrusion, hydrostatic extrusion, calculation of extrusion load, flow pattern in extrusion, defects in extruded parts. **UNIT – V** **SHEET METAL WORKING** Press working operations, blanking and piercing – forces and centre of pressure, strip layout. **BENDING** Terminology, bending methods, bend allowance, Spring back and bending pressure. Cup drawing, simple die, progressive die compound die and combination die. **UNIT – VI** **OTHER FORMING METHODS** Hot and cold spinning, coining, embossing, rubber pad forming, stretch forming. **HIGH ENERGY RATE FORMING METHODS** Explosive forming method, electro hydraulic forming, electromagnetic forming.
TEXT BOOKS:	1.Manufacturing Technology, Foundry forming and welding, Vol I :P.N. Rao, TMH, 5th ed., 2018 2. Metal Forming Technology: Dr. R.Narayana Samy. Ahuja Book Company, 2000.
REFERENCES:	1. Process and Materials of Manufacturing: Lindberg, Pearson India, 2015 2. Manufacturing Technology: Schmid and Kalpakiian, Pearson Education, 2014 3. Fundamentals Metal Forming Processes: B.L.Juneja New age International publishers, 2018 4. Manufacturing Technology: M. Adithan, A.B.Gupta New Age International Publishers, 2012.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

PROFESSIONAL ELECTIVE-IV

20ME41E5 - REFRIGERATION AND AIR-CONDITIONING

(Professional Elective-IV)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 - 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>TD-I & TD-II</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Explains principles and working of various refrigeration systems
2. Describes the component parts and controls of vapour compression refrigeration systems.
3. Explains psychometrics of moist air and apply to HVAC processes.
4. Designing of air-conditioning systems using cooling load calculations
5. Explains comfort air conditioning and equipment required, control systems and ventilation systems</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Explain the principle of refrigeration, cycles, properties and its environment effects.</td><td>K2</td></tr>
<tr><td>CO2</td><td>Explain vapor compression systems and different processes, equipment.</td><td>K2</td></tr>
<tr><td>CO3</td><td>Describe the working principle of various types of refrigeration systems.</td><td>K2</td></tr>
<tr><td>CO4</td><td>Discuss psychrometric properties and processes, and air conditioning process.</td><td>K4</td></tr>
<tr><td>CO5</td><td>Estimate cooling load factor, winter and summer air conditioning load and human comfort condition.</td><td>K4</td></tr>
<tr><td>CO6</td><td>Compare refrigeration and air conditioning systems and make choices for a required application</td><td>K4</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
REFRIGERATION
Introduction, methods of refrigeration, thermodynamic analysis of air cycle and vapor compression refrigeration systems. Vapor absorption system – working of NH_3- water and LiBr – water systems, working of steam jet and thermoelectric refrigeration systems.

UNIT – II
REFRIGERANTS
Properties, classification, nomenclature and selection of refrigerants, alternative refrigerants.
COMPONENTS
Compressors – classification, working of reciprocating and rotary</td></tr>
</table>

	compressors. Condensers – air cooled, water cooled, evaporative condensers, economical water rate, cooling towers, evaporators. **UNIT – III** **DEFROSTING OF EVAPORATORS** Introduction, methods of defrosting- automatic periodic defrosting, defrosting by reversing cycle, automatic hot gas defrosting, thermo bank defrosting and electric defrosting. **REFRIGERATION CONTROL** Automatic and thermostatic expansion valve, capillary tube, compressor controls, miscellaneous controls. Testing and charging of refrigeration units. **UNIT – IV** **AIR CONDITIONING** Fundamental functions of air conditioning, psychrometric properties and processes, sensible heat factor, analysis of air conditioning processes and cycles with psychometric chart, cooling load calculations. **UNIT – V** **AIR CONDITIONING SYSTEMS** Summer, winter, year-round and central systems. **COMFORT AIR CONDITIONING** Physiological reactions to cooling, the effective temperature and its use in the determination of standards of comforts, comfort chart. **CONTROLS** Automatic control of air conditioning systems, air cleaning, ducts, fans. **UNIT – VI** **CRYOGENICS** Introduction, cascade system, liquefaction of gases- air, H_2, applications of low temperature. **APPLICATIONS OF REFRIGERATION** Walk-in-cooler, water coolers, refrigerators, transportation, food processing & preservation. **APPLICATIONS OF AIR CONDITIONING** Domestic, industrial and commercial applications.
TEXT BOOKS:	1. A Course in Refrigeration and Air Conditioning: Arora S.C &DomkundwarS., Dhanpat Rai & Company, 2006. 2. Refrigeration and Air Conditioning: C.P. Arora, Tata McGraw Hill, 2000
REFERENCES:	1. Refrigeration and Air Conditioning : Jordan &Priester, Constable and Company Ltd. London, 2000 2. Principles of Refrigeration : Dossat, 4th ed., Pearson Education India, 1997. 3. Refrigeration and Air Conditioning : Stocker, McGraw-Hill, 2000
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME41E6-CRYOGENIC ENGINEERING

(Professional Elective-IV)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3 - 0 - 0
Prerequisite:	TD-II	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To give fundamental knowledge of types of cryogenic fluids
2. To understand the behaviour of materials and properties at low temperature
3. To learn about Cryogenic refrigeration, requirement of low temperature
4. To understand the Gas separation, purification and measuring instruments

Course Outcomes

Upon successful completion of the course, the students will able to:

CO	Course Outcomes	Knowledge Levels
CO1	Possess basic knowledge of cryogenics.	K2
CO2	Design cryogenic systems.	K4
CO3	Find applications of cryogenics	K1
CO4	Demonstrate the knowledge of cryogenic instrumentation	K2

Course Content

UNIT-I

INTRODUCTION

Cryogenic engineering, properties of cryogenic fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen, Properties of material at cryogenic temperature- mechanical, thermal, and electrical- Super conductivity, application of cryogenic systems in space, medical, industries, biological etc.

UNIT-II

CRYOGENIC REFRIGERATION

Principle and Methods of production of low temperature and their analysis: Joule Thomson Expansion, Cascade processes, Ortho and para hydrogen conversion, cold gas refrigerators, Linde -Hampson cycles, Claude and cascaded systems, magnetic cooling, Stirling Cycle Cryocoolers, Philips refrigerators, Gifford single volume refrigerator, Pulse tube refrigerators

UNIT-III

CRYOGENIC REQUIREMENTS

Cryogenics Heat Exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization. Various insulations (expanded foams, gas filled, fibrous, vacuum, multi-layer

	etc.) and Storage equipment for cryogenic fluids, industrial storage and transfer of cryogenic fluids. **UNIT-IV** **GAS SEPARATION AND PURIFICATION** Ideal gas, mixture characteristics composition diagrams, gas separation, principle of rectification, plate calculation, flash calculation rectification column analysis, separation of air, hydrogen and helium, gas purification methods **UNIT-V** **CRYOGENIC INSTRUMENTATION AND SAFETY** Properties and characteristics of instrumentation, strain displacement, pressure, flow, liquid level, density and temperature measurement in cryogenic range. Safety in cryogenic fluid handling, storage and use. Safety against cryogen hazards like burns, frostbite, asphyxiation, hypothermia etc. **UNIT-VI** **APPLICATIONS** Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions.
TEXT BOOKS:	1. Randal F. Barron, Cryogenic Systems, Oxford University Press, New York, 1999 2. T.M Flynn, Cryogenic Engineering, Maxwell Dekker, 1997. 3. Scoot, Cryogenic Engineering, Van Nostrand Co. Inc. 1985.
REFERENCES:	1. Experimental Techniques in Low Temperature Physics – G.K. White – Osford University Press, England, 1959 2. R W Yance and WM Duke, Applied Cryogenic Engineering, John Willey. 3. Klaus D. Timmerhaus, Richard Palmer Reed, Cryogenic Engineering: 50 years of progress, Springer, 2007.
E-Resources	**1. http://nptel.ac.in/** **2. www.learnerstv.com**

20ME41E7-POWER PLANT ENGINEERING

(Professional Elective-IV)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 -0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>TD-I and TD-II</td><td>Sessional Evaluation :
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Describes the working principle of steam power cycle and layout of steam cycle.
2. Explains and provides knowledge on steam cycle and its application in generation of mechanical power.
3. Describe ash handling, coal handling method in a thermal power plant.
4. Describe feed water systems and control systems for power plants.
5. Describe the generation of power from nuclear reactor.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Describe and analyze different sources of energy, types of power plants and layouts.</td><td>K2</td></tr>
<tr><td>CO2</td><td>Discuss and analyze the working and layout of steam power plants.</td><td>K4</td></tr>
<tr><td>CO3</td><td>Discuss and analyze working principle of diesel and hydro power plant.</td><td>K4</td></tr>
<tr><td>CO4</td><td>Describe the working principle and basic components of the nuclear power plant and safety.</td><td>K2</td></tr>
<tr><td>CO5</td><td>Discuss the working principle and basic components of renewable energy based plants.</td><td>K4</td></tr>
<tr><td>CO6</td><td>Discuss and analyze the economic aspects and compare it with plants of other types.</td><td>K4</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
COAL BASED THERMAL POWER PLANTS: Introduction, layout of modern steam power plant-components, fuel and ash handling, draught system, feed water treatment, Rankine cycle-improvisations.
UNIT – II
HYDRO ELECTRIC POWER PLANTS: Layout - dams- selection of water turbines- types, pumped storage hydel plants, site selection and safety.
UNIT – III
DIESEL ENGINE AND GAS TURBINE POWER PLANTS: Diesel engine power plant layout – components, various operating systems, merits, demerits and applications.</td></tr>
</table>

	Gas turbines – working, types, methods to improve power output and efficiency, layout with inter-cooling, reheating and regeneration. **UNIT – IV** **NUCLEAR POWER PLANTS:** Basics of Nuclear Engineering, Layout and subsystems of Nuclear Power Plants, Working of Nuclear Reactors: Boiling Water Reactor (BWR), Pressurized Water Reactor (PWR), Canada Deuterium Uranium reactor (CANDU), breeder, gas cooled and liquid metal cooled reactors. Safety measures for Nuclear Power plants. **UNIT – V** **RENEWABLE ENERGY BASED PLANTS AND MHD PLANTS:** Power from wind – wind turbine working and types. Solar thermal power plants – low medium and high power generation, power from wave, tidal, geothermal sources, OTEC system, MHD power plants – working, types, merits and demerits. **UNIT – VI** **ECONOMIC AND ENVIRONMENTAL ISSUES OF POWER PLANTS:** Power tariff types, load distribution parameters, load curve, comparison of site selection criteria, relative merits & demerits, capital & operating cost of different power plants. Pollution control technologies including waste disposal options for coal and nuclear power plants.
TEXT BOOKS:	1. Power Plant Engineering: Nag. P.K., Tata McGraw Hill Publishing Company Ltd., 3rd ed., 2008. 2. A Course in Power Plant Engineering: Arora and Domkundwar, Dhanpat Rai and Co.Pvt.Ltd. 2014. 3. Power Plant Engineering: Rajput R.K. Laxmi Publications, 5th ed., 2016.
REFERNCES:	1. Renewable Energy: Godfrey Boyle, Open University, Oxford University Press in association with the Open University, 2004. 2. Power Plant Technology: El-Wakil. M.M., Tata McGrawHill Publishing CompanyLtd.,2010. 3. Power Plant Engineering: Thomas C. Elliott, Kao Chen and Robert C. Swanekamp, Standard Handbook of McGraw Hill, 2nd ed., 1998. 4. Power Plant Engineering: Black & Veatch, Springer, 1996. 5. An Introduction to Power Plant Technology : G.D. Rai, Khanna Publishers, 3rd ed., 1987
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME41E8-INTERNAL COMBUSTION ENGINES
(Professional Elective-IV)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 -0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>TD-I & TD-II</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To understand the operation of internal combustion engines.
2. To perform theoretical calculations to obtain thermodynamic efficiencies and then assess operating losses.
3. To calculate engine operating parameters.
4. To understand the implications of a trade-off between performance, efficiency, emissions.
5. To assess the relation between engine power output to the required power for vehicle propulsion.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Understand working and performance of IC Engines through thermodynamic cycles</td><td>K2</td></tr>
<tr><td>CO2</td><td>Understand combustion phenomena in SI and CI engines and factors influencing combustion chamber design.</td><td>K2</td></tr>
<tr><td>CO3</td><td>Outline emission formation mechanism of IC engines, its effects and the legislation standards</td><td>K2</td></tr>
<tr><td>CO4</td><td>Describe the properties of various alternative fuels, engine modification required and emission characteristic of alternative fuels.</td><td>K2</td></tr>
<tr><td>CO5</td><td>Evaluate methods for improving the IC engine performance</td><td>K4</td></tr>
<tr><td>CO6</td><td>Understand the latest developments in IC Engines and alternate fuels</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
INTRODUCTION: Historical development of internal combustion engines – basic engine types and their operation, comparison of S.I and C.I engines, working of four stroke engines, valve and port timing diagrams.
UNIT – II
COMBUSTION IN SI ENGINES: Stages of combustion in SI engines, abnormal combustion and knocking in SI engines, factors affecting knocking, control of knocking and combustion chambers for SI engines, engine emissions.</td></tr>
</table>

	UNIT – III **COMBUSTION IN CI ENGINES**: Stages of combustion in CI engines, detonation in CI engines, factors affecting detonation, controlling of detonation, importance of proper air movements, combustion chambers for CI engines, engine emissions. **.UNIT – IV** **SUPERCHARGING**: Objectives of supercharging, supercharged S.I. engines, supercharged C.I. engines, effects of supercharging on engine performance, methods of supercharging, superchargers, turbo charging – method of turbo charging, limitations of turbo charging. **UNIT – V** **FOSSIL FUELS**: Requirements of I.C. engine fuels – Hydrocarbon fuels their nature and properties, calorific value, volatility and vapour lock, fuel ratings for S.I engines and C.I. engines, additives. **ALTERNATIVE FUELS**: Alcohol, Hydrogen, Compressed Natural Gas, Liquefied Petroleum Gas and Bio Diesel – Properties, Suitability, Merits and Demerits. **UNIT – VI** **DEVELOPMENTS IN I.C. ENGINES**: Air assisted Combustion, Homogeneous charge compression ignition engines – Variable Geometry turbochargers – Common Rail Direct Injection Systems - Hybrid Electric Vehicles, MPFI.
TEXT BOOKS:	1. A course in Internal Combustion Engines: Mathur, M.L.& Sharma, R.P., Dhanpat Rai, 1999 2. Internal Combustion Engines Fundamentals: Heywood, J.V., McGraw-Hill, 1988 3. Internal Combustion Engines :V.Ganesan, 5th edition, TMH Publication, 2012 4. Internal Combustion Engine Fundamentals: Ramalingam. K.K., Scitech Publications, 2002.
REFERENCES:	1. Internal Combustion Engines : Maleev, V.L., McGraw-Hill, 1945 2. Internal Combustion Engines& Air Pollution : ObertE.F., Harper & Row, 1973 3. Internal Combustion Engines : Lichty, McGraw-Hill, 1951
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

PROFESSIONAL ELECTIVE-V

20ME41E9-FINITE ELEMENTS METHOD
(Professional Elective –V)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3- 0– 0
Prerequisite:	Engineering Mathematics, SOM, HT.	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. Implement the basics of FEM to relate stresses and strains.
2. Formulate the strength of materials and heat transfer problems with application of FEM.
3. Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Levels
CO1	Understand the stress-strain relations, basic concept of FEM and weighted residual methods.	K2
CO2	Formulate 1-D bar and 1-D heat conduction elements Using Weak form and PSTP technique.	K3
CO3	Develop shape functions and element matrices for 1-d structural elements like bars and trusses.	K4
CO4	Apply FE equations for springs, shafts, flow through pipes, heat transfer element and beam element.	K3
CO5	Implement the formulation techniques to solve two-dimensional problems using triangle and quadrilateral elements.	K4
CO6	Perform Numerical Integration, Gaussian quadrature in two dimensions, dynamic analysis and computer implementation.	K4

Course Content

UNIT – I

INTRODUCTION:

EQUATIONS IN SOLVING A STRUCTURAL PROBLEM: Stress at a point, Equations of equilibrium, Strain-Displacement relations, Stress-Strain Relations and Compatibility conditions.

Need for FEM, Comparison with finite difference method, and general procedure for finite element analysis, evaluation of circumference and area of circle. Boundary value, initial value problems and scalar field problems.

WEIGHTED RESIDUAL METHODS: Simple, collocation, Rayleigh-Ritz and Galerkin's methods for bars.

UNIT – II

FINITE ELEMENT FORMULATION FROM WEAK FORM: Derivation of element equations for 1-D bar and 1-D heat conduction elements.

	FINITE ELEMENT FORMULATION BASED ON PSTP: Concept of functional, PSTP, Finite Element Formulation of 1-D bar element from PSTP,meaning of finite element equation. **UNIT – III** **1-DFINITE ELEMENT ANALYSIS:** General form of total potential in 1-D for structural problems,generic form of FE equations,linear bar element, quadratic bar element, derivation of shape functions and element matrices from generic form. **TRUSSES:** Global & element coordinate systems, transformation matrices. **UNIT – IV** **APPLICATIONS OF 1-D FINITE ELEMENT ANALYSIS:** Element equations for discrete systems, linear elastic springs, torsion of circular shafts and flow through pipes,heat transfer element with lateral heat loss (fins), 1-D beam element – degrees of freedom, shape functions and element matrices. **UNIT – V** **2-DFINITE ELEMENT ANALYSIS:** Dimensionality of a problem-plane stress, plane strain and axis-symmetric simplification of structural problems. Approximation of geometry and field variable- simple 3-node triangular element, 4-node rectangular element. Natural coordinates for 4-node quadrilateral element.Generic relations for 4-node rectangular element. **UNIT – VI** **2-D FINITE ELEMENT ANALYSIS:**Numerical integration, Gaussian quadrature in two dimensions. Imposition of boundary conditions and solution of static equilibrium equations. **DYNAMIC ANALYSISUSING FEM:** Formulation for axial vibration of a bar and transverse vibration of a beam. **COMPUTER IMPLEMENTATION:** Outline of aFinite element program.
TEXT BOOKS:	1.A Text Book of Finite Element Analysis: P.Seshu, PHI, 2009 2.An Introduction to Finite Element Method: Reddy J.N. McGraw HillEdition, 3rd ed., 2005. 3.Introduction to Finite Element in Engineering : TirupatiChandrupatla and Belegundu, Pearson Education, 4th Revised, 2012.
REFERENCES:	1.Applied Finite Element Analysis : Larry J Segerlind–John Wiley& Sons., 1976. 2.Finite Element Method : S. S. Rao,Butterworth Heinemann publisher, 2005. 3. Fundamentals of Finite Element Analysis : David V. Hutton TMH Publishers, 2003.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME41E10-GAS DYNAMICS AND JET PROPULSION

(Professional Elective –V)

<table>
<tr><td>Course Category:</td><td>Professional Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3 - 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>TD-II, FM&HM</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. To impart knowledge to the students on compressible flow through ducts, jet propulsion and space propulsion.
2. To understand the basic difference between incompressible and compressible flow.
3. To understand the phenomenon of shock waves and its effect on flow.
4. To gain some basic knowledge about jet propulsion and Rocket Propulsion.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Get knowledge to the students on compressible flow through ducts, jet propulsion and space propulsion.</td><td>K3</td></tr>
<tr><td>CO2</td><td>Understand the basic difference between incompressible and compressible flow.</td><td>K2</td></tr>
<tr><td>CO3</td><td>Understand the phenomenon of shock waves and its effect on flow.</td><td>K2</td></tr>
<tr><td>CO4</td><td>Understand the jet propulsion</td><td>K2</td></tr>
<tr><td>CO5</td><td>Learn about the rocket propulsion</td><td>K1</td></tr>
<tr><td>CO6</td><td>Learn about the types of rocket engine</td><td>K1</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I

BASIC CONCEPTS OF COMPRESSIBLE FLOW
Compressible fluid flow-energy and momentum equations, stagnation stages, various regions of flow, reference velocities, effect of Mach number on compressibility. Types of waves, Mach cone, Mach angle.

UNIT – II

FLOW THROUGH DUCTS-I
Flow through variable area ducts-nozzles and diffusers, Mach number variation, stagnation and critical states, area ratio as a function of Mach number.</td></tr>
</table>

	UNIT – III **FLOW THROUGH DUCTS-II** Flow through constant area ducts-with friction (Fanno flow), with heat transfer (Reyleigh flow), Variation of flow properties. Use of Gas Tables and Charts. **UNIT – IV** **NORMAL AND OBLIQUE SHOCKS** Governing equations, variation of flow parameters across the normal and oblique shocks. Prandtl Meyer relations. Flow in variable area ducts with normal shocks. Use of Tables and Charts. **UNIT – V** **JET PROPULSION** Types of jet engines-turboprop, turbojet, ramjet, pulsejet. Aircraft propulsion theory, performance analysis of jet engines, parameters affecting flight performance, thrust augmentation. **UNIT – VI** **ROCKET PROPULSION** Types of rocket engines, propellants, combustion instabilities, rocket propulsion theory, performance of rocket engine, multistage rockets, orbital and escape velocities.
TEXT BOOKS:	1. John D. Anderson Jr. – 'Modern Compressible Flow with historical perspective' – McGraw Hill Publishing company – International Edition – 1990 – 2nd Edition 2. Yahya S.M. Fundamentals of Compressible Flow, New Age International (P) Ltd., New Delhi, 2003. 3. Ganesan V, Gas Turbines, Tata McGraw-Hill Publishing Company Ltd., 2003.
REFERENCES:	1. Philip G Hill and Carl R. Peterton, Mechanics and Thermodynamics of Propulsion, Addison-Wesley Publishing Company, 1999. 2. Khajuria P.R and Dubey S.P., Gas turbines and Propulsive Systems, DhanpatRaiPublications (P) Ltd, New Delhi 2003. 3. Cohen H. Rogers GFC, Saravanamuttoo HIH, Gas Turbines Theory, Addison-Wesley Long man Ltd., 2001. 4. Balachandran P. – 'Fundamentals of Compressible Fluid Dynamics' – PHI Learning India Private Ltd. – 2009 5. Sutton G. P. – 'Rocket Propulsion Elements' – John Wiley, New York – 1986. 6.Radhakrishnan E. – 'Gas Dynamics' – Prentice-Hall of India Pvt. Ltd – 2004.
E-Resources	**https://nptel.ac.in/courses/**

20ME41E11–TURBO MACHINERY

(Professional Elective –V)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3- 0 - 0
Prerequisite:	Fluid Mechanics, Applied thermodynamics and Heat Transfer.	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. Give an overview of different types of turbo machinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic, steam and gas-turbines.
2. Focus on applications in power generation, transport, refrigeration and the built environment.
3. Teach students how to apply various understandings from other courses. 4. Provide students with opportunities to apply basic flow equations.
5. How to compare and chose machines for various operations.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Levels
CO1	Understand and apply laws of conservation of mass and momentum and energy.	K2
CO2	Specify airfoils for axial flow compressors and understand its design criteria.	K4
CO3	Explain the working principle of centrifugal compressors and know its performance characteristics.	K2
CO4	Understand and classify gas turbines and methods for improving their performance.	K2
CO5	Understand concepts of compressible flow and nozzle design for steam turbines	K2

Course Content

UNIT – I

BASIC THERMODYNAMICS AND FLUID MECHANICS

Introduction, one dimensional compressible flow equations, Equation of motion–energy equation, Euler's turbine equation, Concept of boundary layers, Isentropic flow with varying area, theoretical volume flow rate, Impulse and Reaction Principles, Compression and expansion efficiencies, stage and overall efficiency.

UNIT – II

GAS DYNAMICS

Fundamental thermodynamic concepts, isentropic conditions, mach numbers, and area, Velocity relations, Dynamic Pressure, Normal shock relation for perfect gas. Supersonic flow, oblique shock waves. Normal shock recoveries, detached shocks, Aerofoil theory.

	UNIT – III **AXIAL FLOW COMPRESSOR** Flow Analysis, Work, and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance **UNIT – IV** **CENTRIFUGAL COMPRESSOR** Introduction, Principles of operation, losses to compressor, limitations, inlet and impeller design, characteristic curves, chocked flow. **UNIT – V** **GAS TURBINES** Classification, ideal and modified cycles, component efficiencies effect of maximum temperature, specific output and cycle efficiency, means of improving the performance of simple open cycle, effect of intercooling, reheat and regeneration, combustion chamber requirements. **UNIT – VI** **STEAM TURBINES** Flow through nozzles, effect of Friction, Nozzle performance, Velocity Triangles, Compounding steam turbines, reheat factor, reheating, bleeding, turbine performance at varying loads, throttle and bypass governing, heat drop, mean diameter, speed and number of stages.
TEXT BOOKS:	1. Principles of Turbo Machines/DG Shepherd / Macmillan 2. Turbines, Pumps, Compressors/Yahya/ Mc Graw Hill 3. Gas Turbine Theory, Design and Applications: Khjuria, P.R &Dubey, S.P, 2000
REFERENCES:	1. Steam Turbine Theory and Practice : Kearton, W.J, Pitman publishers, 2005 2. Gas Turbine Theory : Cohen, H & Rogers, G.F.C. 6th ed., 2008 3.Turbines, Compressors and Fans :S. M. Yahya, Tata McGraw-Hill Education, 2010
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME41E12–COMPUTATIONAL FLUID DYNAMICS

(Professional Elective –V)

Course Category:	Professional Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3- 0 - 0
Prerequisite:	Fluid Mechanics, Applied Thermodynamics and Heat Transfer.	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To introduce numerical modelling and its role in automotive field
2. To understand the various discretisation methods and solving methodologies
3. To solve complex problems in the automotive field with the knowledge of Heat transfer and fluid dynamics.
4. To develop finite difference and finite volume discretized forms of the CFD equations
5. To formulate explicit & implicit algorithms for solving the Euler Equations & Navier Stokes Equations

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Levels
CO1	Develop perception of major theories, approaches and methodologies used in CFD.	K4
CO2	Apply differential equations to Fluid Dynamic problems	K3
CO3	Gain the elementary knowledge of finite elements method for flow and heat transfer problems.	K1
CO4	Analyze the numerical simulation to solve major engineering design problems involving fluid flow and heat transfer.	K4
CO5	Build up the skills in the implementation of CFD methods (e.g. boundary conditions.) in actual engineering using commercial CFD codes.	K3

Course Content

UNIT – I

INTRODUCTION AND BASIC CONCEPTS

CFD overview - Applications of CFD.Models of Flow – Conservation and Non-conservation form - Continuity, Momentum and Energy Equation in conservation and non-conservation form (differential equations only) - Characteristics of PDE's - elliptic, parabolic and hyperbolic.

UNIT – II

DISCRETIZATION AND FINITE DIFFERENCE METHOD

DISCRETIZATION:

Basic aspects of Discretization – Comparison of finite difference, finite volume and finite element techniques.

	FINITE DIFFERENCE METHOD: Forward, Backward and Central difference schemes, Transient one 217 and two dimensional conduction - Explicit, implicit, semi-implicit and ADI methods - Stability analysis and error estimation. **UNIT – III** **GRID GENERATION** Choice of grid, grid oriented velocity components, Cartesian velocity components, staggered and collocated arrangements. **UNIT – IV** **CONVECTION AND DIFFUSION** Steady one-dimensional convection and diffusion - Central difference, upwind, quick, exponential, hybrid and power law schemes- False diffusion, SIMPLE – Algorithm. **UNIT – V** **TURBULENCE MODELING** Introduction – Types of Turbulence modeling – Reynolds Time Averaging – Reynolds Time Averaged conservation equations – Boussinesq approach – One equation k -εmodel **UNIT – VI** **CFD CODING** The basic structure of a CFD code: Preprocessor, Solver and Post-processor, User-defined-subroutines, Solution to some basic problems in heat transfer and fluid flow
TEXT BOOKS:	1. Computational Fluid Dynamics: The basics with applications/ John D Anderson/McGraw Hill Publications 2. Numerical Heat Transfer and Fluid Flow/ S.V. Patankar/ Mc Graw Hill 3. H. K. Versteeg& W. Malalasekera, An Introduction to Computational Fluid Dynamics, Longman Scientific & Technical.
REFERENCES:	1. Anil W. Date "Introduction to Computational Fluid Dynamics" Cambridge University Press, 2005. 2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002. 3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005 4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 2014.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

OPEN ELECTIVE-III

20ME41O1 AUTOTRONICS

(OPEN ELECTIVE-III)

Course Category:	Open Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3 -0- 0
Prerequisite:	TD-II	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives	This course provides basic knowledge on the working of automobiles and the electrical and electronic systems in the automobiles		
Course Outcomes	Upon successful completion of the course , the students will able to:		
	CO	**Course Outcomes**	**Knowledge Levels**
	CO1	Acquire the basic knowledge in fundamentals of automotive systems.	K3
	CO2	Acquire the knowledge about fuel injection and ignition systems in automotive systems.	K3
	CO3	Understand the various types of sensors used in automotive applications.	K2
	CO4	Acquire the knowledge in Engine Control Systems	K3
	CO5	Become familiar with advanced comfort and safety systems used in automobiles	K4
	CO6	Become familiar with electric and hybrid vehicles.	K4

Course Content

UNIT – I

AUTOMOTIVE FUNDAMENTALS

The Engine-Components- Charging systems: Working and design of charging circuit diagram – Alternators – Requirements of starting system - Starter motors and starter circuits.

Emission laws – introduction to Euro I, Euro II, Euro III, Euro IV, Euro V standards – Equivalent Bharat Standards.

UNIT – II

IGNITION AND INJECTION SYSTEMS

Ignition systems: Ignition fundamentals – Drawbacks of conventional ignition system- Electronic ignition systems - Direct ignition – Spark Plugs.

Electronic fuel Control: Draw backs of carbureted type, electronic petrol injection system-classification-SPI-MPFI-types of MPFI systems. Electronic diesel injection system-electronically controlled injection pumps.

	UNIT – III **AUTOMOTIVE SENSORS AND ACTUATORS** Introduction-Working Principle of Sensors-throttle position sensors-manifold pressure sensor-mass air flow sensor-engine coolant temperature sensors-vehicle speed sensors-crankshaft position sensors-exhaust gas oxygen sensors, Actuators: exhaust gas recirculation actuators, stepper motor actuator, and vacuum operated actuator. **UNIT – IV** **ENGINE CONTROL SYSTEMS** Control modes for fuel control-engine control subsystems – ignition control methodologies – different ECU‟s used in the engine management – block diagram of the engine management system. In vehicle networks: CAN standard, format of CAN standard – diagnostics systems in modern automobiles. **UNIT – V** **CHASSIS AND SAFETY SYSTEMS** Traction control system – Cruise control system – electronic control of automatic transmission – antilock braking system – electronic suspension system – working of airbag and role of MEMS in airbag systems – centralized door locking system – climate control of cars **UNIT – VI** **ELECTRIC AND HYBRID VEHICLES** Introduction-Electric vehicle development-system layout-basic system components-Fuel cell Electric vehicle. Hybrid vehicle: Series hybrid vehicle- Parallel hybrid vehicle-CNG Electric Hybrid Vehicle
TEXT BOOKS:	1. Tom Denton, “Automobile Electrical and Electronics Systems”, Edward Arnold Publishers, 2000.
REFERENCES:	1. Ribbens, "Understanding Automotive Electronics", 7th Edition, Elsevier, Indian Reprint, 2013. 2. Barry Hollembeak, “Automotive Electricity, Electronics & Computer Controls”, Delmar Publishers, 2001. 3. Richard K. Dupuy “Fuel System and Emission controls”, Check Chart Publication, 2000. 4. Ronald. K. Jurgon, “Automotive Electronics Handbook”, McGraw-Hill, 1999.
E-Resources	**1. https://youtu.be/c0zl7449pwE** **2. https://youtu.be/z94jk49JzCk**

20ME41O2 - SOLAR ENERGY ENGINEERING

(Open Elective-III)

<table>
<tr><td>Course Category:</td><td>Open elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3- 0 - 0</td></tr>
<tr><td>Prerequisite:</td><td>Physic, TD-I, TD-II and Heat transfer</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1. Understand the phases of the Sun and its energy transport and solar radiation data
2. Understand the fundamentals of flat plat collectors and thermal analysis of flat plate collectors
3. Identify the different reasons behind using concentrating collectors over flat plates and Understand the fundamentals of flat plat collectors
4. Know about the energy storage issues involved in solar energy
5. Know the different applications of solar energy</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Understand the outline and fundamentals of the Sun and its energy transport and Solar radiation geometry</td><td>K2</td></tr>
<tr><td>CO2</td><td>Understand the overview of the Flat Plate Collectors and their applications</td><td>K2</td></tr>
<tr><td>CO3</td><td>Elucidate the knowledge of focusing type collectors for reducing the disadvantages of flat plat collectors</td><td>K3</td></tr>
<tr><td>CO4</td><td>Analyze and compare the different energy storing modes of solar energy</td><td>K4</td></tr>
<tr><td>CO5</td><td>Evaluate the suitability of various storage of solar energy modes for different applications</td><td>K4</td></tr>
<tr><td>CO6</td><td>Summarize and operational characteristics for the applications of solar energy</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I
THE PHYSICS OF SOLAR ENERGY: The phases of the Sun and its energy transport, solar radiation geometry, calculation of radiation intercepted by surfaces, instruments for measuring solar radiation, solar radiation data.
UNIT – II
FLAT PLATE COLLECTORS: Energy balance equation, thermal analysis of flat plate collectors, transmission of cover system, heat transport systems, collector efficiency and materials.</td></tr>
</table>

	UNIT – III **CONCENTRATING COLLECTORS:** Importance, types, performance analysis of cylindrical parabolic concentrating collector, advantages and disadvantages of concentrating collectors over flat plate collectors. **UNIT – IV** **SOLAR ENERGY STORAGE**: Types, thermal- sensible, latent, phase change materials. **PHOTOVOLTAIC SYSTEMS**: Semiconductors, Photovoltaic panels. Types of photovoltaic technologies; Equipment related to photovoltaic technology, batteries, invertors, charge controllers, peak power trackers. **UNIT – V** **SOLAR HEATING**: Solar Water heating, Passive solar water heating systems, Thermal siphon systems, Integrated collector storage systems. **SOLAR COOKERS AND SOLAR DRIERS:** Types of solar cookers - Solar box type solar cooker, SK type solar cooker (parabolic), Solar steam cooking system. Classification of solar dryers - Active and passive solar energy dryers. **UNIT – VI** **SOLAR APPLICATIONS:** Solar pumping, solar distillation, solar green houses, solar production of hydrogen, space cooling. **SOLAR THERMAL POWER SYSTEMS**: Solar thermal power generation schemes, parabolic trough solar power generating systems, central receiver power plants (solar power towers), chimney power plants.
TEXT BOOKS:	1.Solar Energy Utilization: G.D. Rai, Khanna Publishers, 2004. 2. Principles of Solar Engineering: Frank Kreith and Jan F Kreider, Taylor & Francis, 2000.
REFERENCES:	1. Solar Energy Thermal Process: Dufice& Beckman, John Wiley & Sons, 1991 2. Solar Energy and Non-conventional Energy Sources : Domakundwar, Dhanpat Rai & Co., Pvt. Ltd., 2018
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME41O3–MECHATRONICS

(Open Elective-III)

Course Category:	Open Elective	**Credits:**	3
Course Type:	Theory	**Lecture - Tutorial - Practical:**	3- 0 - 0
Prerequisite:	TOM-I &II and Electronics Engineering Principles	**Sessional Evaluation :** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. Understand the fundamentals and scope of mechatronics
2. Understand the fundamentals of sensors and actuators
3. Understand the fundamentals of control systems
4. Understand the fundamentals of programmable logic controllers
5. To design the mechatronics systems

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Levels
CO1	Explain basic needs of mechatronics.	K2
CO2	Explain and select the need of sensors and actuators for automation techniques.	K2
CO3	Explain and design the control systems for automation techniques.	K2
CO4	Explain and design programmable logic controllers	K2
CO5	Design of Mechatronics Systems for the product applications.	K4

Course Content

UNIT – I

INTRODUCTION

Introduction to Mechatronics, Scope of Mechatronics, Electronics for Mechanical Engineer, Mechanical systems for Electronic Engineer.

UNIT – II

SENSORS

Introduction, Position and Speed measurement. ACTUATORS: Solenoids and relays, electric motors, D. C. Motors, Stepper motors, Selecting a Motor, Mechanical, Hydraulic and Pneumatic actuators, brief treatment.

UNIT – III

BRIEF INTRODUCTION TO CONTROL SYSTEMS

Control Systems – Closed loop and open loop control system. Feedback characteristics; Fundamentals of Analog and Digital Control Systems - block diagrams; Block diagrams of discrete time (Sampled data digital) components. Control Systems and Computer Controlled Systems, Servo Mechanics.

	UNIT – IV **PROGRAMMABLE PERIPHERAL INTERFACE** Introduction – Architecture of 8255, Keyboard interfacing, LED display –interfacing, ADC and DAC interface, Temperature Control – Stepper Motor Control – Traffic Control interface. **UNIT – V** **PLC (PROGRAMMABLE LOGIC CONTROLLERS)** Introduction, PLC programming, Mnemonics, Timers, Internal relay, counters, specifications and selection of PLC. **UNIT – VI** **DESIGN OF MECHATRONICS SYSTEMS** Introduction, automatic front and back end cutting in steel rolling mill, lift control system, CNC lathe, Temperature control of a heat treatment furnace, electrode arm control in electric arc furnace.
TEXT BOOKS:	1. Bolton, "Mechatronics", Prentice Hall, 2008 2. Ramesh S Gaonkar, "Microprocessor Architecture, Programming, and Applications with the 8085", 5th Edition, Prentice Hall, 2008. 3.Shanmugham N, Mechatronics, Anuradha Publications, 2009
REFERENCES:	1. Bradley D.A, Dawson D, Buru N.C and Loader A.J, "Mechatronics", Chapman and Hall, 1993. 2. Clarence W, de Silva, "Mechatronics" CRC Press, First Indian Re-print, 2013 3. Devadas Shetty and Richard A. Kolk, "Mechatronics Systems Design", PWS publishing company, 2007. 4. Krishna Kant, "Microprocessors & Microcontrollers", Prentice Hall of India, 2007. 5. Michael B.Histand and Davis G.Alciatore, "Introduction to Mechatronics and Measurement systems", McGraw Hill International edition, 2007.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

OPEN ELECTIVE-IV

20ME41O4 INTERNET OF THINGS
(Offered by Department of Mechanical Engineering)
(Open Elective-IV)

<table>
<tr><td>Course Category:</td><td>Open Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture - Tutorial - Practical:</td><td>3-0-0</td></tr>
<tr><td>Prerequisite:</td><td>Basic Computers, C</td><td>Sessional Evaluation :
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives</td><td colspan="3">1.To assess the vision and introduction of IoT.
2. To Understand IoT Market perspective.
3. To Implement Data and Knowledge Management and use of Devices in IoT Technology.
4. To Understand State of the Art - IoT Architecture.
5. To classify Real World IoT Design Constraints, Industrial Automation in IoT.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon successful completion of the course , the students will able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Interpret the vision of IoT from a global context.</td><td>K4</td></tr>
<tr><td>CO2</td><td>Determine the Market perspective of IoT.</td><td>K4</td></tr>
<tr><td>CO3</td><td>Compare and Contrast the use of Devices, Gateways and Data Management in IoT</td><td>K4</td></tr>
<tr><td>CO4</td><td>Implement state of the art architecture in IoT.</td><td>K2</td></tr>
<tr><td>CO5</td><td>Illustrate the application of IoT in Industrial Automation and identify Real World Design Constraints.</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT – I

INTRODUCTION & CONCEPTS: Introduction to Internet of Things, Physical Design of IOT, Logical Design of IOT, IOT Enabling Technologies, IOT Levels.

UNIT – II

DOMAIN SPECIFIC IOTs: Home automation, cities, environment, energy, retail, logistics, agriculture, industry, health & life style.

UNIT – III

M2M: M2M, Difference between IOT and M2M, SDN and NFV for IOT, software defined networking, network function virtualization, need for IOT systems management, simple network management protocol, limitations of SNMP, and network operator requirements.</td></tr>
</table>

	UNIT – IV **CLOUD COMPUTING BASICS:** Cloud computing basics, terminology, characteristics, services, cloud deployment – public, private environments, secure communication, cloud security. **UNIT – V** **DEVELOPING INTERNET OF THINGS & LOGICAL DESIGN USING PYTHON:** Introduction, IOT design methodology, installing python, python data types & data structures, control flow, functions, modules, packages, file handling, date/ time operations, classes, python packages. **UNIT-VI** **IOT PHYSICAL DEVICES & ENDPOINTS:** What is an IOT Device, exemplary device, board, Linux on raspberry pi, interfaces, and programming & IOT devices.
TEXT BOOKS:	1. Internet of Things A Hands-On- Approach : Vijay Madisetti, ArshdeepBagha, 2014.
REFERENCES:	1. Designing the Internet of Things : Adrian McEwen, Wiley Publishers, 2013. 2. The Silent Intelligence - The Internet of Things : Daniel Kellmereit, 2013.
E-Resources	**1.https://nptel.ac.in/courses** **2.https://freevideolectures.com/university/iitm**

20ME41O5 DESIGN AND ANALYSIS OF ALGORITHMS
(Open Elective-IV)

<table>
<tr><td>Course Category:</td><td>Open Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td>Theory</td><td>Lecture – Tutorial – Practical:</td><td>3-0-0</td></tr>
<tr><td>Pre-requisite:</td><td>Basic Programming (C, C++)</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objective</td><td colspan="3">Obtaining efficient algorithms is very important in modern computer engineering as the world wants applications to be time and space and energy efficient. This course enables to understand and analyze efficient algorithms for various applications.</td></tr>
<tr><td>Course Outcomes</td><td colspan="3">Upon the successful completion of the course, the students will be able to:
<table>
<tr><th>CO</th><th>Course Outcomes</th><th>Knowledge Levels</th></tr>
<tr><td>CO1</td><td>Analyze the time and space complexity of an algorithm</td><td>K4</td></tr>
<tr><td>CO2</td><td>Understand and implement fundamental algorithms</td><td>K2</td></tr>
<tr><td>CO3</td><td>Understand and implement fundamental algorithms (Trees)</td><td>K2</td></tr>
<tr><td>CO4</td><td>Explain the major graph algorithms and their analysis</td><td>K2</td></tr>
<tr><td>CO5</td><td>Understand searching and sorting</td><td>K2</td></tr>
<tr><td>CO6</td><td>Understand about the various storage devices</td><td>K2</td></tr>
</table></td></tr>
<tr><td>Course Content</td><td colspan="3">UNIT-I

Introduction: What is an Algorithm? , Algorithm Specification, Analysis Framework, Performance Analysis: Space complexity, Time complexity, Asymptotic Notations: Big-Oh notation (O), Omega notation (Ω), Theta notation, and Little-oh notation (o), Mathematical analysis of Non-Recursive and recursive Algorithms with Examples. Important Problem Types: Sorting, Searching, String processing, Graph Problems, Combinatorial Problems.

UNIT-II

Stack and Queue and Link List: Stack operation, PUSH and POP, Array representation of stacks, Operation associated with stacks Application of stacks, Recursion, Polish expression, Representation Queue, operation on Queue , Priority Queue , D-Queue , Singly and circularly linked list, List operations Lists implementations</td></tr>
</table>

	UNIT-III **Trees :** Basic terminology, Binary Trees, Binary tree representation, Algebraic/expressions, Complete Binary Trees, Extended binary tree, representing binary tress in memory, linked representation of Binary trees, Traversing binary trees & Searching in binary trees, Inserting in binary search trees, Complexity of searching algorithm, Heaps, general trees, Threaded binary tree. **UNIT-IV** **Graphs:** Terminology & representations, Graphs & Multigraphs, Directed Graphs, Sequential representation of graphs, adjacency Matrices, Transversal, connected component and spanning trees, Minimum Cost spanning tree, Prims and Kruskal Algorithm, BFS, DFS, Shortest path and transitive closure, Activity networks, topological sort and critical paths. **UNIT-V** **Searching and Sorting:** Linear search, binary Search, Internal and External sorting, Bubble sorting, selection sort, Insertion sort, quick sort, Two-way merge sort, Heap sort, sorting on different keys, practical consideration for internal sorting, External Sorting. **UNIT-VI** **Storage Devices:** Magnetic tapes, Disk Storage, Sorting with disks and Indexing techniques, introduction to B tree and B+ tree, File organization and storage management, Introduction to hoisting
TEXT BOOKS:	1. Thomas H. Coreman, Charles E. Leiserson and Ronald L. Rivest, "Introduction to Algorithms", PHI. 2. Horowitz and Sahani, "Fundamentals of Data Structures", Galgotia Publication. 3. Weiss, "Data Structure & Algorithm Analysis in C", Addision Wesley. 4. Basse, "computer Algorithms: Introduction to Design & Analysis", Addision Wesley. 5. Aho, Hopcroft, Ullman, "Data Structure & Algorithm", Addision Wesley. 6. Aho, Hopcroft, Ullman, "The Design and Analysis of Computer Algorithms" Pearson Education, 2008
REFERENCES:	1. E. Horowitz et al. Fundamentals of Algorithms 2. Gills Brassard, Paul Bratley, Fundamental of Algorithms PHI. 3. Anany Levitin, Introduction to Design and Analysis of Algorithms, Pearson. 4. Shailesh R Sathe, Foundations of Algorithms, Penram 5. Dave and Dave, Design and Analysis of Algorithms, Pearson.
e-Resources:	**1. https://nptel.ac.in/courses/106106131**

20ME41O6 PRODUCT LIFE CYCLE MANAGEMENT
(Open Elective-IV)

<table>
<tr><td>Course Category:</td><td colspan="2">Open Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td colspan="2">Theory</td><td>Lecture – Tutorial – Practical:</td><td>3-0-0</td></tr>
<tr><td>Pre-requisite:</td><td colspan="2">Industrial Engineering & Management</td><td>Sessional Evaluation:
External Exam Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objective</td><td colspan="4">All industries that have tangible products need to understand PLM. Professionals who have responsibilities in engineering, manufacturing, or information systems or who have strategic planning responsibilities at the corporate or divisional levels will benefit from an understanding of PLM and its implementation</td></tr>
<tr><td rowspan="8">Course Outcomes</td><td colspan="4">Upon the successful completion of the course, the students will be able to:</td></tr>
<tr><td>CO</td><td colspan="2">Course Outcomes</td><td>Knowledge Levels</td></tr>
<tr><td>CO1</td><td colspan="2">Impart the latest knowledge, principles, strategies, practices, and applications in PLM domain.</td><td>K3</td></tr>
<tr><td>CO2</td><td colspan="2">Provide an in-depth understanding of various applications and solutions of PLM.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Build conceptual foundation of PLM, along with the latest industry views on PLM applications.</td><td>K3</td></tr>
<tr><td>CO4</td><td colspan="2">Present frameworks which provide economic justifications for PLM projects.</td><td>K4</td></tr>
<tr><td>CO5</td><td colspan="2">Understand about product life cycle environment.</td><td>K2</td></tr>
<tr><td>CO6</td><td colspan="2">Understand the various components of PLM.</td><td>K2</td></tr>
<tr><td>Course Content</td><td colspan="4">UNIT – I
INTRODUCTION TO PRODUCT LIFE CYCLE MANAGEMENT
Product life cycle – Introduction, growth, maturity & decline, Product Lifecycle Management- Definition & Overview, Background for PLM-corporate challenges, Need of PLM, Components/Elements of PLM, Emergence of PLM, Significance of PLM - life cycle problems to be resolved, product development problems to be resolved, Customer Involvement
UNIT-II
CONSTRUCTING PRODUCT LIFE CYCLE MANAGEMENT & DRIVING ENVIRONMENT
PLM Life cycle model- plan, design, build, support & dispose. Threads of PLMcomputer aided design (CAD), engineering data management (EDM), Product data management (PDM), computer integrated manufacturing (CIM). Weaving the threads into PLM, comparison of PLM to Engineering resource planning (ERP). PLM characteristics - singularity, cohesion, traceability, reflectiveness, Information Mirroring Model. External drivers-scale, complexity, cycle times, globalization & regulation. Internal drivers -</td></tr>
</table>

	productivity, innovation, collaboration & quality. Board room drivers – income, revenues & costs. **UNIT-III** **DIGITAL LIFE CYCLE** Collaborative Product Development, Mapping Requirements to specifications. Part Numbering, Engineering Vaulting, Product reuse, Engineering Change Management, Bill of Material and Process Consistency. Digital Mock up and Prototype development. Virtual testing and collateral. Introduction to Digital Manufacturing. **UNIT-IV** **PRODUCT LIFE CYCLE MANAGEMENT SYSTEM** Product life cycle management system- system architecture, Information models and product structure, Information model, the product information data model, the product model, functioning of the system. Reasons for the deployment of PLM systems **UNIT-V** **PRODUCT LIFE CYCLE ENVIRONMENT** Product Data issues – Access, applications, Archiving, Availability, Change, Confidentiality. Product Workflow, The Link between Product Data and Product Workflow, Key Management Issues around Product Data and Product Workflow, Company's PLM vision, The PLM Strategy, Principles for PLM strategy, Preparing for the PLM strategy, Developing a PLM strategy, Strategy identification and selection, Change Management for PLM**.** **UNIT-VI** **COMPONENTS OF PRODUCT LIFE CYCLE MANAGEMENT** Different phases of product lifecycle and corresponding technologies, Foundation technologies and standards e.g. visualization, collaboration and enterprise application integration, Core functions e.g., data vaults, document and content management, workflow and program management, Functional applications e.g., configuration management. Human resources in product lifecycle. PLM Case Study.
TEXT BOOKS:	1. Grieves Michael, Product Lifecycle Management- Driving the Next Generation of Lean Thinking, McGraw-Hill, 2006. ISBN 0071452303 2.Kari Ulrich and Steven D. Eppinger, Product Design & Development, McGraw Hill International Edns, 1999.
REFERENCES:	1.Antti Saaksvuori, AnselmiImmonen, Product Life Cycle Management - Springer, 1st Edition (Nov.5, 2003) 2. Stark, John. Product Lifecycle Management: 21st Century Paradigm for Product Realization, Springer-Verlag, 2004. ISBN 1852338105.
e-Resources:	1. https://youtu.be/ePZheUvsH0w 2. https://youtu.be/ny4JMkmVHj4 3. https://youtu.be/CB5VYBJEjWI 4. https://youtu.be/e7h_luzUA-Q 5. https://youtu.be/1jKXz47f260 6. https://youtu.be/YiHC6_AlK50 7. https://youtu.be/59bPqwRQq7s 8. https://youtu.be/vqHFqy1UudA

20SHM41O1 STATISTICAL METHODS

(S&H ELECTIVE)

<table>
<tr><td>Course Category:</td><td colspan="2">Science & Humanities Elective</td><td>Credits:</td><td>3</td></tr>
<tr><td>Course Type:</td><td colspan="2">Theory</td><td>Lecture -Tutorial-Practical:</td><td>3-0-0</td></tr>
<tr><td>Pre – requisite:</td><td colspan="2">Probability and probability distributions</td><td>Sessional Evaluation:
External Evaluation:
Total Marks:
External Exam Duration:</td><td>40
60
100
3 hrs</td></tr>
<tr><td>Course Objectives:</td><td colspan="4">To make the student learn about
1. The basic concepts of Sampling Distribution and estimation
2. The Testing of Hypothesis and Type I & II errors
3. The basic concepts of Small sample tests
4. The concept of Statistical Quality Control
5. The various methods of Analysis of Variance (ANOVA)
6. The correlation and regression concepts</td></tr>
<tr><td rowspan="8">Course Outcomes:</td><td colspan="4">After completing the course, the student will be able to</td></tr>
<tr><td>CO</td><td colspan="2">Course Outcomes</td><td>Knowledge Levels</td></tr>
<tr><td>CO1</td><td colspan="2">Have a good grasp of Sampling distribution of the mean proportions, Sums and differences, Point Estimation and Interval Estimation</td><td>K3</td></tr>
<tr><td>CO2</td><td colspan="2">Understood the Type I and Type II errors - Proportions of Hypothesis testing.</td><td>K2</td></tr>
<tr><td>CO3</td><td colspan="2">Acquire knowledge in Small sample tests and independence of attributes.</td><td>K3</td></tr>
<tr><td>CO4</td><td colspan="2">Have a sound knowledge in the methods of Statistical Quality Control</td><td>K3</td></tr>
<tr><td>CO5</td><td colspan="2">Have a good grasp of Analysis of Variance (ANOVA)</td><td>K3</td></tr>
<tr><td>CO6</td><td colspan="2">Acquire basic knowledge in Correlation and Regression</td><td>K3</td></tr>
</table>

Course Content:	**UNIT - I** **Sampling Distribution:** Population and Samples-Sampling distribution of the mean, proportions, Sums and differences. Estimation: Point Estimation-Interval Estimation **UNIT - II** **Testing of Hypothesis/Large Sample** **Introduction to testing hypothesis** – Null and alternative hypothesis, Type I and Type II errors, critical region. Level of significance, One tail, two tail tests. **Test of Hypothesis**: Means - Hypothesis concerning one and two means, proportions- Hypothesis concerning one and two proportions. **UNIT-III** **Small Sample**: Small sample tests-Student's t-test-single and double means, F-test, Chi-Square test-Goodness of fit and independence of attributes. **UNIT – IV** **Statistical Quality Control**: Introduction to Quality Control, Product Control and Process Control, 3σ limits, Tolerance limits Control charts for measurements ($\bar{x}$ and R charts)-Control charts for attributes (p,c) **UNIT-V** **Analysis of Variance:** One way and Two way classifications - Completely randomized design – Randomized block design – Latin square design **UNIT – VI** **Correlation and Regression:** Correlation-Rank Correlation. Simple linear regression, Regression lines, Regression coefficients and its properties.
TEXTBOOKS:	1. Higher Engineering Mathematics - B.S. Grewal, Khanna Publishers, New Delhi. 2. Probability and Statistics for engineers and scientists, R.E.Walpole, R.H.Myers, S.L.Mayers and K.Ye, 9th Edition, Pearson Education (2012). 3. Applied Statistics and Probability for Engineers, Douglas C. Montgomery, George C. Runger, 6th Edition, John Wiley & Sons (2016).
REFERENCES:	1. S.C. Gupta; "Fundamentals of Statistics 7th Edition" ; Himalaya Publishing House Pvt. Ltd. 2. Probability and Statistics, J.L.Devore, 8th Edition, Brooks/Cole, Cengage Learning (2012). 3. Probability and Statistics for Engineers, R.A.Johnson, Miller Freund‟s, 8th edition, Prentice Hall India (2011). 4. Probability, Statistics and Reliability for Engineers and Scientists, Bilal M. Ayyub and Richard H. McCuen, Third Edition, CRC press (2011).

20ME41SC CAE/CAM LABORATORY

(SKILL ADVANCED COURSE-III)

Course Category:	Skill Advanced Course	**Credits:**	2
Course Type:	Practical	**Lecture - Tutorial - Practical:**	0-0-4
Prerequisite:	CAD/CAM	**Sessional Evaluation:** **External Exam Evaluation:** **Total Marks:** **External Exam Duration:**	40 60 100 3 hrs

Course Objectives

1. To study the basics of CAD.
2. Fluent application of engineering techniques, tools and resources.
3. To study Geometric modeling and assembling of any mechanical system.
4. To make appropriate selection of CAD functionality to use as tools in the design process.

Course Outcomes

Upon successful completion of the course , the students will able to:

CO	Course Outcomes	Knowledge Levels
CO1	Apply knowledge of CAD for generation of curves.	K3
CO2	Interpret engineering technical drawings of parts and assemblies according to engineering design standards.	K6
CO3	Demonstrate skill of modeling and assembling of any mechanical system.	K2
CO4	Prepare to be an effective user of a CAD/CAM system.	K6

Course Content

List of Experiments for CAD/CAE Lab

1. FEA of a Simple supported beam with different loadings
2. FEA of a Bimetallic rod
3. Static Analysis of a 2D truss
4. Stress distribution in a plate with circular hole
5. Heat transfer in a composite wall
6. Analysis of an aluminium bracket
7. Dynamic analysis of truss.
8. Simulation of simple machining operations
9. Modelling and simulation of a revolute joint
10. Creation of a manufacturing cell
11. Virtual production system to track real-time production activities, perform schedule changes, launch new programs

Note: Experiments 1 to 7 are using ABAQUS and 8-11 are using DELMIA