



**B.Tech. in MECHANICAL ENGINEERING**  
**COURSE STRUCTURE, I & II YEAR SYLLABUS (J-22 Regulations)**

**Applicable from AY 2022-23 Batch**

**I YEAR I SEMESTER**

S.No.	Course Code		Course Title	L	T	P	Credits
1.	MA101BS	BS	Matrices and Calculus	3	1	0	4
2.	PH102BS	BS	Applied Physics	3	1	0	4
3.	CS103ES	ES	C Programming and Data Structures	3	0	0	3
4.	ME104ES	ES	Engineering Workshop	0	1	3	2.5
5.	EN105BS	BS	English for Skill Enhancement	2	0	0	2
6.	ME106PC	PC	Elements of Mechanical Engineering	0	0	2	1
7.	PH107BS	BS	Applied Physics Laboratory	0	0	3	1.5
8.	EN108HS	HS	English Language and Communication Skills Laboratory	0	0	2	1
9.	CS109ES	ES	C Programming and Data Structures Laboratory	0	0	2	1
10.	MC110ES	ES	Environmental Science	3	0	0	0
11.			Induction Programme				
<b>Total</b>				<b>14</b>	<b>3</b>	<b>12</b>	<b>20</b>

**I YEAR II SEMESTER**

S. No.	Course Code		Course Title	L	T	P	Credits
1.	MA201BS	BS	Ordinary Differential Equations and Vector Calculus	3	1	0	4
2.	CH202BS	BS	Engineering Chemistry	3	1	0	4
3.	ME203ES	ES	Computer Aided Engineering Graphics	1	0	4	3
4.	ME204ES	ES	Engineering Mechanics	3	0	0	3
5.	ME205ES	ES	Engineering Materials	2	0	0	2
6.	CS206BS	BS	Python Programming Laboratory	0	1	2	2
7.	CH207BS	BS	Engineering Chemistry Laboratory	0	0	2	1
8.	ME208ES	ES	Fuels & Lubricants Laboratory	0	0	2	1
<b>Total</b>				<b>12</b>	<b>3</b>	<b>10</b>	<b>20</b>

**II YEAR I SEMESTER**

S. No	Course Code		Course Title	L	T	P	Credits
1	22MA304	BS	Probability, Statistics & Complex Variables	3	1	0	4
2	22ME302	PC	Mechanics of Solids	3	0	0	3
3	22ME303	PC	Metallurgy & Material Science	3	0	0	3
4	22ME304	PC	Production Technology	3	0	0	3
5	22ME305	PC	Thermodynamics	3	1	0	4
6	22ME306	PC	Production Technology Laboratory	0	0	2	1
7	22ME307	PC	Material Science & Mechanics of Solids Laboratory	0	0	2	1
8	22ME308	PC	Computer Aided Machine Drawing	0	0	2	1
9	*22MC310		Constitution of India	3	0	0	0
<b>Total Credits</b>				<b>18</b>	<b>2</b>	<b>6</b>	<b>20</b>

**II YEAR II SEMESTER**

S. No	Course Code		Course Title	L	T	P	Credits
1	22EE401	ES	Basic Electrical and Electronics Engineering	3	0	0	3
2	22ME402	PC	Kinematics of Machinery	3	0	0	3
3	22ME403	PC	Fluid Mechanics & Hydraulic Machines	3	0	0	3
4	22ME404	PC	IC Engines & Gas Turbines	3	0	0	3
5	22ME405	PC	Instrumentation and Control Systems	3	0	0	3
6	22EE406	ES	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
7	22ME407	PC	Fluid Mechanics & Hydraulic Machines Laboratory	0	0	2	1
8	22ME408	PC	Instrumentation and Control Systems Laboratory	0	0	2	1
9	22ME409	PC	Real-time Research Project/ Field-Based Project	0	0	4	2
10	22MC409		Gender Sensitization Lab	0	0	2	0
			<b>Total Credits</b>	<b>15</b>	<b>0</b>	<b>12</b>	<b>20</b>

**III YEAR I SEMESTER**

S. No.	Course Code		Course Title	L	T	P	Credits
1.	22ME501	PC	Dynamics of Machinery	3	0	0	3
2.	22ME502	PC	Design of Machine Elements	3	0	0	3
3.	22ME503	PC	Metrology & Machine Tools	3	0	0	3
4.	22SM504	MS	Business Economics & Financial Analysis	3	0	0	3
5.	22ME505	PC	Steam Power & Jet Propulsion	3	0	0	3
6.	22ME506	PC	CAD/CAM	2	0	0	2
7.	22ME507	PC	Thermal Engineering Laboratory	0	0	2	1
8.	22ME508	PC	Metrology & Machine Tools Laboratory	0	0	2	1
9.	22ME509	PC	Kinematics & Dynamics Laboratory	0	0	2	1
10.	*22MC508		Intellectual Property Rights	3	0	0	0
			<b>Total Credits</b>	<b>20</b>	<b>0</b>	<b>6</b>	<b>20</b>

**III YEAR II SEMESTER**

S. No	Course Code		Course Title	L	T	P	Credits
1	22ME601	PC	Machine Design	3	0	0	3
2	22ME602	PC	Heat Transfer	3	0	0	3
3	22ME603	PC	Finite Element Methods	3	0	0	3
4			Professional Elective - I	3	0	0	3
5			Open Elective - I	3	0	0	3
6	22ME604	PC	Heat Transfer Lab	0	0	2	1
7	22ME605	PC	Computer Aided Engineering Laboratory	0	0	2	1
8	22EN606	HS	Advanced English Communication Skills Laboratory	0	0	2	1
9	22ME607	PC	Industry Oriented Mini Project/ Internship	0	0	4	2
10	*22MC608		Environmental Science	3	0	0	0
			<b>Total Credits</b>	<b>18</b>	<b>0</b>	<b>10</b>	<b>20</b>

**Environmental Science in III Yr II SEM should be registered by Lateral Entry Students Only.**

**IV YEAR I SEMESTER**

S. No.	Course Code		Course Title	L	T	P	Credits
1	22ME701	PC	Industrial Management	2	0	0	2
2	22ME702	PC	Refrigeration & Air Conditioning	3	0	0	3
3			Professional Elective – II	3	0	0	3
4			Professional Elective – III	3	0	0	3
5			Professional Elective - IV	3	0	0	3
6			Open Elective - II	3	0	0	3
7	22ME703	PC	Project Stage - I	0	0	6	3
			<b>Total Credits</b>	<b>17</b>	<b>0</b>	<b>6</b>	<b>20</b>

**IV YEAR II SEMESTER**

S. No.	Course Code		Course Title	L	T	P	Credits
1			Professional Elective – V	3	0	0	3
2			Professional Elective - VI	3	0	0	3
3			Open Elective - III	3	0	0	3
4	22ME801	PC	Project Stage – II including seminar	0	0	22	9+2
			<b>Total Credits</b>	<b>9</b>	<b>0</b>	<b>22</b>	<b>20</b>

\*MC – Satisfactory/Unsatisfactory

**PROFESSIONAL ELECTIVES OFFERED IN J-22****Professional Elective - I**

22ME611PE	Unconventional Machining Processes
22ME612PE	Power Plant Engineering
22ME613PE	Mechanical Vibrations
22ME614PE	Microprocessors in Automation

**Professional Elective – II**

22ME711PE	Artificial Intelligence in Mechanical Engineering
22ME712PE	Automobile Engineering
22ME713PE	Industrial Robotics
22ME714PE	Mechatronics

**Professional Elective – III**

22ME721PE	Production Planning & Control
22ME722PE	Computational Fluid Dynamics
22ME723PE	Composite Materials
22ME724PE	Solar energy technology



### Professional Elective – IV

22ME731PE	Re-Engineering
22ME732PE	Non-Conventional Energy Sources
22ME733PE	Operations Research
22ME734PE	Electric and Hybrid Vehicles

### Professional Elective – V

22ME811PE	Automation in Manufacturing
22ME812PE	Turbo Machinery
22ME813PE	Additive Manufacturing
22ME814PE	Energy Conservation and Management

### Professional Elective – VI

22ME821PE	Industry 4.0
22ME822PE	Fluid Power System
22ME823PE	Fuzzy Logic and ANN
22ME824PE	Total Quality Management

## List of Open Electives

### Open Elective (OE – I)

1. Basic Mechanical Engineering
2. Renewable energy Sources

### Open Elective (OE – II)

1. Quantitative Analysis for Business Decisions
2. Industrial Engineering & Management

### Open Elective (OE – III)

1. Entrepreneurship Development
2. Elements of Electric and Hybrid vehicles



## MATRICES AND CALCULUS - MA101BS

**B.Tech. I Year I Sem.**

**L T P C**  
**3 1 0 4**

**Pre-requisites:** Mathematical Knowledge at pre-university level

**Course Objectives:** To learn

- Types of matrices and their properties.
- Concept of a rank of the matrix and applying this concept to know the consistency and solving the system of linear equations.
- Concept of eigenvalues and eigenvectors and to reduce the quadratic form to canonical form
- Geometrical approach to the mean value theorems and their application to the mathematical problems
- Evaluation of surface areas and volumes of revolutions of curves.
- Evaluation of improper integrals using Beta and Gamma functions.
- Partial differentiation, concept of total derivative
- Finding maxima and minima of function of two and three variables.
- Evaluation of multiple integrals and their applications

**Course outcomes:** After learning the contents of this paper the student must be able to

- Write the matrix representation of a set of linear equations and to analyse the solution of the system of equations
- Find the Eigenvalues and Eigen vectors
- Reduce the quadratic form to canonical form using orthogonal transformations.
- Solve the applications on the mean value theorems.
- Evaluate the improper integrals using Beta and Gamma functions
- Find the extreme values of functions of two variables with/ without constraints.
- Evaluate the multiple integrals and apply the concept to find areas, volumes

### **UNIT-I: Matrices**

**10 L**

Rank of a matrix by Echelon form and Normal form, Inverse of Non-singular matrices by Gauss-Jordan method, System of linear equations: Solving system of Homogeneous and Non-Homogeneous equations by Gauss elimination method, Gauss Seidel Iteration Method.

### **UNIT-II: Eigen values and Eigen vectors**

**10 L**

Linear Transformation and Orthogonal Transformation: Eigenvalues, Eigenvectors and their properties, Diagonalization of a matrix, Cayley-Hamilton Theorem (without proof), finding inverse and power of a matrix by Cayley-Hamilton Theorem, Quadratic forms and Nature of the Quadratic Forms, Reduction of Quadratic form to canonical forms by Orthogonal Transformation.

### **UNIT-III: Calculus**

**10 L**

Mean value theorems: Rolle's theorem, Lagrange's Mean value theorem with their Geometrical Interpretation and applications, Cauchy's Mean value Theorem, Taylor's Series.

Applications of definite integrals to evaluate surface areas and volumes of revolutions of curves (Only in Cartesian coordinates), Definition of Improper Integral: Beta and Gamma functions and their applications.

### **UNIT-IV: Multivariable Calculus (Partial Differentiation and applications)**

**10 L**

Definitions of Limit and continuity.

Partial Differentiation: Euler's Theorem, Total derivative, Jacobian, Functional dependence & independence. Applications: Maxima and minima of functions of two variables and three variables using method of Lagrange multipliers.



### **UNIT-V: Multivariable Calculus (Integration)**

**8 L**

Evaluation of Double Integrals (Cartesian and polar coordinates), change of order of integration (only Cartesian form), Evaluation of Triple Integrals: Change of variables (Cartesian to polar) for double and (Cartesian to Spherical and Cylindrical polar coordinates) for triple integrals.

Applications: Areas (by double integrals) and volumes (by double integrals and triple integrals).

#### **TEXT BOOKS:**

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36<sup>th</sup> Edition, 2010.
2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5<sup>th</sup> Edition, 2016.

#### **REFERENCE BOOKS:**

1. Erwin kreyszig, Advanced Engineering Mathematics, 9<sup>th</sup> Edition, John Wiley & Sons, 2006.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9<sup>th</sup> Edition, Pearson, Reprint, 2002.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.
4. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S Chand and Company Limited, New Delhi.



## APPLIED PHYSICS - PH102BS

**B.Tech. I Year I Sem.**

**L T P C**  
**3 1 0 4**

**Pre-requisites:** 10 + 2 Physics

**Course Objectives:** The objectives of this course for the student are to:

1. Understand the basic principles of quantum physics and band theory of solids.
2. Understand the underlying mechanism involved in construction and working principles of various semiconductor devices.
3. Study the fundamental concepts related to the dielectric, magnetic and energy materials.
4. Identify the importance of nanoscale, quantum confinement and various fabrications techniques.
5. Study the characteristics of lasers and optical fibres.

**Course Outcomes:** At the end of the course the student will be able to:

1. Understand physical world from fundamental point of view by the concepts of Quantum mechanics and visualize the difference between conductor, semiconductor, and an insulator by classification of solids.
2. Identify the role of semiconductor devices in science and engineering Applications.
3. Explore the fundamental properties of dielectric, magnetic materials and energy for their applications.
4. Appreciate the features and applications of Nanomaterials.
5. Understand various aspects of Lasers and Optical fiber and their applications in diverse fields.

### UNIT - I: QUANTUM PHYSICS AND SOLIDS

Quantum Mechanics: Introduction to quantum physics, blackbody radiation – Stefan-Boltzmann's law, Wein's and Rayleigh-Jean's law, Planck's radiation law - photoelectric effect - Davisson and Germer experiment –Heisenberg uncertainty principle - Born interpretation of the wave function – time independent Schrodinger wave equation - particle in one dimensional potential box.

Solids: Symmetry in solids, free electron theory (Drude & Lorentz, Sommerfeld) - Fermi-Dirac distribution - Bloch's theorem -Kronig-Penney model – E-K diagram- effective mass of electron-origin of energy bands- classification of solids.

### UNIT - II: SEMICONDUCTORS AND DEVICES

Intrinsic and extrinsic semiconductors – Hall effect - direct and indirect band gap semiconductors - construction, principle of operation and characteristics of P-N Junction diode, Zener diode and bipolar junction transistor (BJT)–LED, PIN diode, avalanche photo diode (APD) and solar cells, their structure, materials, working principle and characteristics.

### UNIT - III: DIELECTRIC, MAGNETIC AND ENERGY MATERIALS

Dielectric Materials: Basic definitions- types of polarizations (qualitative) - ferroelectric, piezoelectric, and pyroelectric materials – applications – liquid crystal displays (LCD) and crystal oscillators.

Magnetic Materials: Hysteresis - soft and hard magnetic materials - magnetostriction, magnetoresistance - applications - bubble memory devices, magnetic field sensors and multiferroics.

Energy Materials: Conductivity of liquid and solid electrolytes- superionic conductors - materials and electrolytes for super capacitors - rechargeable ion batteries, solid fuel cells.

### UNIT - IV: NANOTECHNOLOGY

Nanoscale, quantum confinement, surface to volume ratio, bottom-up fabrication: sol-gel, precipitation, combustion methods – top-down fabrication: ball milling - physical vapor deposition (PVD) - chemical vapor deposition (CVD) - characterization techniques - XRD, SEM & TEM - applications of nanomaterials.



## UNIT - V: LASER AND FIBER OPTICS

**Lasers:** Laser beam characteristics-three quantum processes-Einstein coefficients and their relations- lasing action - pumping methods- ruby laser, He-Ne laser , CO<sub>2</sub> laser, Argon ion Laser, Nd:YAG laser- semiconductor laser-applications of laser.

**Fiber Optics:** Introduction to optical fiber- advantages of optical Fibers - total internal reflection-construction of optical fiber - acceptance angle - numerical aperture- classification of optical fibers-losses in optical fiber - optical fiber for communication system - applications.

### TEXT BOOKS:

1. M. N. Avadhanulu, P.G. Kshirsagar & TVS Arun Murthy” A Text book of Engineering Physics”- S. Chand Publications, 11<sup>th</sup> Edition 2019.
2. Engineering Physics by Shatendra Sharma and Jyotsna Sharma, Pearson Publication,2019
3. Semiconductor Physics and Devices- Basic Principle – Donald A, Neamen, Mc Graw Hill, 4<sup>th</sup>Edition,2021.
4. B.K. Pandey and S. Chaturvedi, Engineering Physics, Cengage Learning, 2<sup>nd</sup>Edition,2022.
5. Essentials of Nanoscience & Nanotechnology by Narasimha Reddy Katta, Typical Creatives NANO DIGEST, 1<sup>st</sup> Edition, 2021.

### REFERENCE BOOKS:

1. Quantum Physics, H.C. Verma, TBS Publication, 2<sup>nd</sup> Edition 2012.
2. Fundamentals of Physics – Halliday, Resnick and Walker, John Wiley & Sons, 11<sup>th</sup> Edition, 2018.
3. Introduction to Solid State Physics, Charles Kittel, Wiley Eastern, 2019.
4. Elementary Solid State Physics, S.L. Gupta and V. Kumar, Pragathi Prakashan, 2019.
5. A.K. Bhandhopadhyaya - Nano Materials, New Age International, 1<sup>st</sup> Edition, 2007.
6. Energy Materials a Short Introduction to Functional Materials for Energy Conversion and Storage Aliaksandr S. Bandarenka, CRC Press Taylor & Francis Group
7. Energy Materials, Taylor & Francis Group, 1<sup>st</sup> Edition, 2022.





## C PROGRAMMING AND DATA STRUCTURES- CS103ES

B.Tech. I Year I Sem.

L T P C  
3 0 0 3

**Course Objectives:** Introduce the importance of programming, C language constructs, program development, data structures, searching and sorting.

### Course Outcomes:

1. Understand the various steps in Program development.
2. Explore the basic concepts in C Programming Language.
3. Develop modular and readable C Programs
4. Understand the basic concepts such as Abstract Data Types, Linear and Non-Linear Data structures.
5. Apply data structures such as stacks, queues in problem solving
6. To understand and analyze various searching and sorting algorithms.

### UNIT – I

**Introduction to Computers** – Computer Systems, Computing Environments, Computer Languages, Creating and running programs, Software Development

**Introduction to C Language** – Background, Simple C programs, Identifiers, Basic data types, Variables, Constants, Input / Output

**Structure of a C Program** – Operators, Bit-wise operators, Expressions, Precedence and Associativity, Expression Evaluation, Type conversions, Statements.

### UNIT – II

**Statements** – if and switch statements, Repetition statements – while, for, do-while statements, Loop examples, other statements related to looping – break, continue, go to, Recursion.

**Designing Structured Programs-** Functions, basics, user defined functions, inter function communication, standard functions.

**Arrays** – Concepts, using arrays in C, inter function communication, array applications, two – dimensional, multidimensional arrays.

### UNIT – III

**Pointers** – Introduction, Pointers for inter function communication, pointers to pointers, compatibility,

**Pointer Applications** – Passing an array to a function, Memory allocation functions, array of pointers

**Strings** – Concepts, C Strings, String Input / Output functions, arrays of strings, string manipulation functions, string / data conversion.

### UNIT – IV

**Derived types** – The Typedef, enumerated types, Structures – Declaration, definition and initialization of structures, accessing structures, operations on structures, complex structures. Unions – Referencing unions, initializers, unions and structures.

**Input and Output** – Text vs Binary streams, standard library functions for files, converting file types, File programs – copy, merge files.

### UNIT – V

**Sorting-** selection sort, bubble sort, insertion sort,

**Searching-**linear and binary search methods.

**Data Structures** – Introduction to Data Structures, abstract data types, Linear list – singly linked list implementation, insertion, deletion and searching operations on linear list, Stacks-Operations, array and linked representations of stacks, stack applications, Queues-operations, array and linked representations.



## TEXT BOOKS:

1. C Programming & Data Structures, B.A.Forouzan and R.F. Gilberg, Third Edition, Cengage Learning.
2. Problem Solving and Program Design in C, J.R. Hanly and E.B. Koffman, Fifth Edition, Pearson Education.
3. The C Programming Language, B.W. Kernighan and Dennis M.Ritchie, PHI/Pearson Education

## REFERENCE BOOKS:

1. C & Data structures – P. Padmanabham, 3rd Edition, B.S. Publications.
2. C Programming with problem solving, J.A. Jones & K. Harrow, Dreamtech Press
- 3 Programming in C – Stephen G. Kochan, III Edition, Pearson Education.
4. C for Engineers and Scientists, H. Cheng, McGraw-Hill International Edition
5. Data Structures using C – A. M. Tanenbaum, Y. Langsam, and M.J. Augenstein, Pearson Education / PHI
6. C Programming & Data Structures, E. Balagurusamy, TMH.
7. C Programming & Data Structures, P. Dey, M Ghosh R Thereja, Oxford University Press
8. C & Data structures – E V Prasad and N B Venkateswarlu, S. Chand & Co.



## ENGINEERING WORKSHOP- ME104ES

B.Tech. I Year I Sem.

L T P C  
0 1 3 2.5

**Pre-requisites:** Practical skill

### Course Objectives:

- To Study of different hand operated power tools, uses and their demonstration.
- To gain a good basic working knowledge required for the production of various engineering products.
- To provide hands on experience about use of different engineering materials, tools, equipments and processes those are common in the engineering field.
- To develop a right attitude, team working, precision and safety at work place.
- It explains the construction, function, use and application of different working tools, equipment and machines.
- To study commonly used carpentry joints.
- To have practical exposure to various welding and joining processes.
- Identify and use marking out tools, hand tools, measuring equipment and to work to prescribed tolerances.

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

- CO 1: Study and practice on machine tools and their operations
- CO 2: Practice on manufacturing of components using workshop trades including plumbing, fitting, carpentry, foundry, house wiring and welding.
- CO 3: Identify and apply suitable tools for different trades of Engineering processes including drilling, material removing, measuring, chiseling.
- CO 4: Apply basic electrical engineering knowledge for house wiring practice.

### 1. TRADES FOR EXERCISES:

**At least two exercises from each trade:**

- I. Carpentry – (T-Lap Joint, Dovetail Joint, Mortise & Tenon Joint)
- II. Fitting – (V-Fit, Dovetail Fit & Semi-circular fit)
- III. Tin-Smithy – (Square Tin, Rectangular Tray & Conical Funnel)
- IV. Foundry – (Preparation of Green Sand Mould using Single Piece and Split Pattern)
- V. Welding Practice – (Arc Welding & Gas Welding)
- VI. House-wiring – (Parallel & Series, Two-way Switch and Tube Light)
- VII. Black Smithy – (Round to Square, Fan Hook and S-Hook)

### 2. TRADES FOR DEMONSTRATION & EXPOSURE:

Plumbing, Machine Shop, Metal Cutting (Water Plasma), Power tools in construction and WoodWorking.

### 3. Additional trades:

**Demonstration of plastic molding and metal casting process.**

### TEXT BOOKS:

1. Workshop Practice /B. L. Juneja / Cengage
2. Workshop Manual / K. Venugopal / Anuradha.

### REFERENCE BOOKS:

1. Work shop Manual - P. Kannaiah/ K.L. Narayana/ Scitech
2. Workshop Manual / Venkat Reddy/ BSP



## List of Equipment

### ENGINEERING WORKSHOP – LAB

S.No	Name of the Equipment
1	BENCHES
2	CARPENTRY VISES
3	CARPENTRY TOOLS, VIZ., CHISELS,SAWS,JACK PLANES,FILES,STEEL RULES ETC.,
4	WOOD TURNING LATHE
5	WOOD PIECES TO CONDUCT EXPERIMENT
6	BENCH VISES
7	FITTING TOOLS, VIZ., FLAT FILES,ROUND FILES,HACK SAW BLADES AND FRAMES VERNIER GAUGE ETC.,
8	METAL PIECES FOR CONDUCTING EXPERIMENT
9	TIN SMITHY TOOLS, VIZ., SMITHS,RULERS,DOT PUNCHES,SCRIBES,WOODEN MALLETS,HAMMERS,ETC.,
10	SHEET METAL PIECES FOR CONDUCTING EXPERIMENTS
11	OIL FIRED,COAL FIRED BLACK SMITHY FURNACE
12	ANVIL
13	SWAGE BLOCK
14	SLEDGE HAMMER
15	TONGS AND OTHER BLACK SMITHY TOOLS
16	WIRING BOARD
17	WIRING TOOLS
18	WIRING CABLES
19	FOUNDRY TOOLS VIZ., RAMMER,MOULDING BOARDS ETC.,
20	COPE AND DRAG WITH SWEEPS
21	DIFFERENT PATTERN
22	CORE BOXES
23	ARC WELDING MACHINE
24	TIG WELDING MACHINE
25	WELDING TOOLS VIZ., HOLDERS,SAFETY EQUIPMENT ETC.,
26	POWER HACKSAW,DRILLING MACHINE AND BENCH GRINDER
27	PIPE VISE
28	PLUMBING TOOLS AND PIPE SAMPLES
29	LATHE MACHINE WITH ALL ACCESSORIES
30	LABORATORY MODEL OF WATER PLASMA CUTTING MACHINE



## ENGLISH FOR SKILL ENHANCEMENT -EN105BS

**B.Tech. I Year I Sem.**

**L T P C**  
**2 0 0 2**

**Course Objectives:** This course will enable the students to:

1. Improve the language proficiency of students in English with an emphasis on Vocabulary, Grammar, Reading and Writing skills.
2. Develop study skills and communication skills in various professional situations.
3. Equip students to study engineering subjects more effectively and critically using the theoretical and practical components of the syllabus.

**Course Outcomes:** Students will be able to:

1. Understand the importance of vocabulary and sentence structures.
2. Choose appropriate vocabulary and sentence structures for their oral and written communication.
3. Demonstrate their understanding of the rules of functional grammar.
4. Develop comprehension skills from the known and unknown passages.
5. Take an active part in drafting paragraphs, letters, essays, abstracts, précis and reports in various contexts.
6. Acquire basic proficiency in reading and writing modules of English.

### UNIT - I

Chapter entitled 'Toasted English' by R.K.Narayan from "English: Language, Context and Culture" published by Orient BlackSwan, Hyderabad.

**Vocabulary:** The Concept of Word Formation -The Use of Prefixes and Suffixes - Acquaintance with Prefixes and Suffixes from Foreign Languages to form Derivatives - Synonyms and Antonyms

**Grammar:** Identifying Common Errors in Writing with Reference to Articles and Prepositions.

**Reading:** Reading and Its Importance- Techniques for Effective Reading.

**Writing:** Sentence Structures -Use of Phrases and Clauses in Sentences- Importance of Proper Punctuation- Techniques for Writing precisely – Paragraph Writing – Types, Structures and Features of a Paragraph - Creating Coherence-Organizing Principles of Paragraphs in Documents.

### UNIT - II

Chapter entitled 'Appro JRD' by Sudha Murthy from "English: Language, Context and Culture" published by Orient Black Swan, Hyderabad.

**Vocabulary:** Words Often Miss pelt - Homophones, Homonyms and Homographs

**Grammar:** Identifying Common Errors in Writing with Reference to Noun-pronoun Agreement and Subject-verb Agreement.

**Reading:** Sub-Skills of Reading – Skimming and Scanning – Exercises for Practice

**Writing:** Nature and Style of Writing- Defining /Describing People, Objects, Places and Events – Classifying- Providing Examples or Evidence.

### UNIT - III

Chapter entitled 'Lessons from Online Learning' by F.Haider Alvi, Deborah Hurst et al from "English: Language, Context and Culture" published by Orient BlackSwan, Hyderabad.

**Vocabulary:** Words Often Confused - Words from Foreign Languages and their Use in English.

**Grammar:** Identifying Common Errors in Writing with Reference to Misplaced Modifiers and Tenses.

**Reading:** Sub-Skills of Reading – Intensive Reading and Extensive Reading – Exercises for Practice.



**Writing:** Format of a Formal Letter-Writing Formal Letters E.g., Letter of Complaint, Letter of Requisition, Email Etiquette, Job Application with CV/Resume.

#### **UNIT - IV**

Chapter entitled 'Art and Literature' by Abdul Kalam from "English: Language, Context and Culture" published by Orient Black Swan, Hyderabad.

**Vocabulary:** Standard Abbreviations in English

**Grammar:** Redundancies and Clichés in Oral and Written Communication.

**Reading:** Survey, Question, Read, Recite and Review (SQ3R Method) - Exercises for Practice

**Writing:** Writing Practices- Essay Writing-Writing Introduction and Conclusion -Précis Writing.

#### **UNIT - V**

Chapter entitled 'Go, Kiss the World' by Subroto Bagchi from "English: Language, Context and Culture" published by Orient Black Swan, Hyderabad.

**Vocabulary:** Technical Vocabulary and their Usage

**Grammar:** Common Errors in English (Covering all the other aspects of grammar which were not covered in the previous units)

**Reading:** Reading Comprehension-Exercises for Practice

**Writing:** Technical Reports- Introduction – Characteristics of a Report – Categories of Reports Formats- Structure of Reports (Manuscript Format) -Types of Reports - Writing a Report.

**Note:** Listening and Speaking Skills which are given under Unit-6 in AICTE Model Curriculum are covered in the syllabus of ELCS Lab Course.

- **Note:** 1. As the syllabus of English given in AICTE Model Curriculum-2018 for B.Tech First Year is Open-ended, besides following the prescribed textbook, it is required to prepare teaching/learning materials by the teachers collectively in the form of handouts based on the needs of the students in their respective colleges for effective teaching/learning in the class.
- **Note:** 2. Based on the recommendations of NEP2020, teachers are requested to be flexible to adopt Blended Learning in dealing with the course contents. They are advised to teach 40 percent of each topic from the syllabus in blended mode.

#### **TEXT BOOK:**

1. "English: Language, Context and Culture" by Orient BlackSwan Pvt. Ltd, Hyderabad. 2022. Print.

#### **REFERENCE BOOKS:**

1. Effective Academic Writing by Liss and Davis (OUP)
2. Richards, Jack C. (2022) Interchange Series. Introduction, 1,2,3. Cambridge University Press
3. Wood, F.T. (2007). Remedial English Grammar. Macmillan.
4. Chaudhuri, Santanu Sinha. (2018). Learn English: A Fun Book of Functional Language, Grammar and Vocabulary. (2<sup>nd</sup> ed.,). Sage Publications India Pvt. Ltd.
5. (2019). Technical Communication. Wiley India Pvt. Ltd.
6. Vishwamohan, Aysha. (2013). English for Technical Communication for Engineering Students. Mc Graw-Hill Education India Pvt. Ltd.
7. Swan, Michael. (2016). Practical English Usage. Oxford University Press. Fourth Edition.



## ELEMENTS OF MECHANICAL ENGINEERING- ME106PC

**B.Tech. I Year I Sem.**

L	T	P	C
0	0	2	1

**Course Objectives:** The objectives of this course are to

1. Make the student to experimentally measure the common geometric properties like length, diameter, flatness, curvature, volume and moment of inertia etc.
2. Give a practical knowledge to evaluate the friction between surfaces and also to evaluate the natural frequency of the system.
3. Correlate between theory and experimental results, directly observe the proof of principles and theories through practical knowledge
4. Introduce students to the basic concepts of manufacturing through the demonstration of various processes.
5. Understand the commonly used mechanical components like gear box, working of boilers and IC engine etc.

**Course Outcomes:** At the end of the course, students will be able to:

1. CO 1: Understand the operation, usage and applications of different measuring instruments and tools.
2. CO 2: Examine the different characteristics of instruments like accuracy, precision etc
3. CO 3: Prepare simple composite components and joining different materials using soldering process.
4. CO 4: Identify tools & learn practically the process of turning, milling, grinding on mild steel pieces.
5. CO 5: Understand the basic components of IC engine, Gear box and boiler

**List of Experiments to be performed:**

1. Measurement of length, height, diameter by vernier calipers.
2. To measure diameter of a given wire and sphere, thickness of a given sheet and volume of an irregular lamina using micrometer screw gauge.
3. Use of straight edge and spirit level in finding the flatness of surface plate.
4. Determination of time period and natural frequency of simple pendulum.
5. Determination of time period and natural frequency of compound pendulum.
6. To measure the coefficients of static and kinetic friction between a block and a plane using various combination of materials.
7. To determine the radius of curvature of a given spherical surface.
8. The experimental determination of the Moment of Inertia of regular and irregular solids.
9. Metal joining process—soldering of metal alloys to any PCB board
10. A simple composite geometry preparation by hand layup method.
11. Grouping of Dry cells for a specified voltage and current and its measurement using ammeters and voltmeters etc.
12. Demonstration of lathe, milling, drilling, grinding machine operations.
13. Study of transmission system –gear box
14. Assembly /disassembly of Engines
15. Study of Boilers

**Note:** Perform any 10 out of the 15 Exercises.



## LIST OF EQUIPMENTS

### ELEMENTS OF MECHANICAL ENGINEERING -LAB

S.No	Name of the Equipment
1	VERNIER CALLIPERS
2	MICROMETER SCREWGUAGE
3	SIMPLE PENDULUM
4	COMPOUND PENDULUM
5	BLOCK ON INCLINED PLANE PROVISION
6	SPHEROMETER
7	RECTANGULAR BLOCK AND A FLYWHEEL
8	SOLDERING IRON,SOLDER WICK,PCB BOARD
9	HAND LAYUP METHOD
10	AMMETER
11	VOLTMETER
12	DRYCELLS
13	GEARBOX OF FOUR WHEELER VEHICLE
14	OLD ENGINE MODEL
15	DEMONSTRATION OF LATHE ,MILLING,DRILLING,AND GRINDING MACHINE OPERATIONS
16	BOILER MODELS; LANCASHIRE BOILER,BABCOK AND WILCOX BOILER,LOCOMOTIVE BOILER





## APPLIED PHYSICS LABORATORY- PH107BS

B.Tech. I Year I Sem.

L T P C  
0 0 3 1.5

**Course Objectives:** The objectives of this course for the student to

1. Capable of handling instruments related to the Hall effect and photoelectric effect experiments and their measurements.
2. Understand the characteristics of various devices such as PN junction diode, Zener diode, BJT, LED, solar cell, lasers and optical fiber and measurement of energy gap and resistivity of semiconductor materials.
3. Able to measure the characteristics of dielectric constant of a given material.
4. Study the behavior of B-H curve of ferromagnetic materials.
5. Understanding the method of least squares fitting.

**Course Outcomes:** The students will be able to:

1. Know the determination of the Planck's constant using Photo electric effect and identify the material whether it is n-type or p-type by Hall experiment.
2. Appreciate quantum physics in semiconductor devices and optoelectronics.
3. Gain the knowledge of applications of dielectric constant.
4. Understand the variation of magnetic field and behavior of hysteresis curve.
5. Carried out data analysis.

### LIST OF EXPERIMENTS:

1. Determination of work function and Planck's constant using photoelectric effect.
2. Determination of Hall co-efficient and carrier concentration of a given semiconductor.
3. Characteristics of series and parallel LCR circuits.
4. V-I characteristics of a p-n junction diode and Zener diode
5. Input and output characteristics of BJT (CE, CB & CC configurations)
6. a) V-I and L-I characteristics of light emitting diode (LED)  
b) V-I Characteristics of solar cell
7. Determination of Energy gap of a semiconductor.
8. Determination of the resistivity of semiconductor by two probe method.
9. Study B-H curve of a magnetic material.
10. Determination of dielectric constant of a given material
11. a) Determination of the beam divergence of the given LASER beam  
b) Determination of Acceptance Angle and Numerical Aperture of an optical fiber.
12. Understanding the method of least squares – torsional pendulum as an example.

**Note:** Any 8 experiments are to be performed.

### REFERENCE BOOK:

1. S. Balasubramanian, M.N. Srinivasan "A Text book of Practical Physics"- S Chand Publishers, 2017



## List of Equipments

### APPLIED PHYSICS – LAB

Sl.no	Name of the Equipment
1	PHOTOELECTRIC EFFECT ( WORK FUNCTION AND PLANK'S CONSTANT)
2	HALL EFFECT (HALL COEFF. AND CARRIER CONC.)
3	LCR – CIRCUIT (SERIES AND PARALLEL CHARACTERISTICS)
4	PN JUNCTION DIODE (V-I CHARACTERISTICS)
5	ZENER DIODE (V-I CHARACTERISTICS)
6	CHARACTERISTICS OF BJT
7	CHARACTERISTICS OF LED
8	CHARACTERISTICS OF SOLAR CELL
9	ENERGY GAP OF SEMICONDUCTOR
10	RESISTIVITY OF SEMICONDUCTOR(TWO PROBE METHOD)
11	B-H CURVE OF MAGNETIC MATERIAL
12	DIELECTRIC CONSTANT OF GIVEN MATERIAL
13	BEAM DIVERGENCE OF LASER
14	ACCEPTANCE ANGLE AND NUMERICAL APERTURE (OPTICAL FIBER)
15	METHOD OF LEAST SQUARES – TORSIONAL PENDULUM



## ENGLISH LANGUAGE AND COMMUNICATION SKILLS LABORATORY- EN108HS

**B.Tech. I Year I Sem.**

**L T P C**  
**0 0 2 1**

The **English Language and Communication Skills (ELCS) Lab** focuses on the production and practice of sounds of language and familiarizes the students with the use of English in everyday situations both in formal and informal contexts.

### Course Objectives:

- ✓ To facilitate computer-assisted multi-media instruction enabling individualized and independent language learning
- ✓ To sensitize the students to the nuances of English speech sounds, word accent, intonation and rhythm
- ✓ To bring about a consistent accent and intelligibility in students' pronunciation of English by providing an opportunity for practice in speaking
- ✓ To improve the fluency of students in spoken English and neutralize the impact of dialects.
- ✓ To train students to use language appropriately for public speaking, group discussions and interviews

### Course Outcomes: Students will be able to:

- ✓ Understand the nuances of English language through audio- visual experience and group activities
- ✓ Neutralise their accent for intelligibility
- ✓ Speak with clarity and confidence which in turn enhances their employability skills

### Syllabus: English Language and Communication Skills Lab (ELCS) shall have two parts:

- a. **Computer Assisted Language Learning (CALL) Lab**
- b. **Interactive Communication Skills (ICS) Lab**

### Listening Skills:

#### Objectives

1. To enable students develop their listening skills so that they may appreciate the role in the LSRW skills approach to language and improve their pronunciation
2. To equip students with necessary training in listening, so that they can comprehend the speech of people of different backgrounds and regions

Students should be given practice in listening to the sounds of the language, to be able to recognize them and find the distinction between different sounds, to be able to mark stress and recognize and use the right intonation in sentences.

- Listening for general content
- Listening to fill up information
- Intensive listening
- Listening for specific information

### Speaking Skills:

#### Objectives

1. To involve students in speaking activities in various contexts
  2. To enable students express themselves fluently and appropriately in social and professional contexts
- Oral practice
  - Describing objects/situations/people
  - Role play – Individual/Group activities
  - Just A Minute (JAM) Sessions



The following course content is prescribed for the **English Language and Communication Skills Lab**.

### **Exercise – I**

#### **CALL Lab:**

Understand: Listening Skill- Its importance – Purpose- Process- Types- Barriers- Effective Listening.

Practice: Introduction to Phonetics – Speech Sounds – Vowels and Consonants – Minimal Pairs- Consonant Clusters- Past Tense Marker and Plural Marker- Testing Exercises

#### **ICS Lab:**

Understand: Spoken vs. Written language- Formal and Informal English.

Practice: Ice-Breaking Activity and JAM Session- Situational Dialogues – Greetings – Taking Leave – Introducing Oneself and Others.

### **Exercise – II**

#### **CALL Lab:**

Understand: Structure of Syllables – Word Stress– Weak Forms and Strong Forms – Stress pattern in sentences – Intonation.

Practice: Basic Rules of Word Accent - Stress Shift - Weak Forms and Strong Forms- Stress pattern in sentences – Intonation - Testing Exercises

#### **ICS Lab:**

Understand: Features of Good Conversation – Strategies for Effective Communication.

Practice: Situational Dialogues – Role Play- Expressions in Various Situations –Making Requests and Seeking Permissions - Telephone Etiquette.

### **Exercise - III**

#### **CALL Lab:**

Understand: Errors in Pronunciation-Neutralising Mother Tongue Interference (MTI).

Practice: Common Indian Variants in Pronunciation – Differences between British and American Pronunciation -Testing Exercises

#### **ICS Lab:**

Understand: Descriptions- Narrations- Giving Directions and Guidelines – Blog Writing

Practice: Giving Instructions – Seeking Clarifications – Asking for and Giving Directions – Thanking and Responding – Agreeing and Disagreeing – Seeking and Giving Advice – Making Suggestions.

### **Exercise – IV**

#### **CALL Lab:**

Understand: Listening for General Details.

Practice: Listening Comprehension Tests - Testing Exercises

#### **ICS Lab:**

Understand: Public Speaking – Exposure to Structured Talks - Non-verbal Communication- Presentation Skills.

Practice: Making a Short Speech – Extempore- Making a Presentation.

### **Exercise – V**

#### **CALL Lab:**

Understand: Listening for Specific Details.

Practice: Listening Comprehension Tests -Testing Exercises

#### **ICS Lab:**

Understand: Group Discussion

Practice: Group Discussion



## Minimum Requirement of infrastructural facilities for ELCS Lab:

### 1. Computer Assisted Language Learning (CALL) Lab:

The Computer Assisted Language Learning Lab has to accommodate 40 students with 40 systems, with one Master Console, LAN facility and English language learning software for self- study by students.

#### System Requirement (Hardware component):

Computer network with LAN facility (minimum 40 systems with multimedia) with the following specifications:

- i) Computers with Suitable Configuration
- ii) High Fidelity Headphones

### 2. Interactive Communication Skills (ICS) Lab :

**The Interactive Communication Skills Lab:** A Spacious room with movable chairs and audio-visual aids with a Public Address System, a T. V. or LCD, a digital stereo –audio & video system and camcorder etc.

#### Source of Material (Master Copy):

- Exercises in Spoken English. Part 1,2,3. CIEFL and Oxford University Press

**Note:** Teachers are requested to make use of the master copy and get it tailor-made to suit the contents of the syllabus.

#### Suggested Software:

- Cambridge Advanced Learners' English Dictionary with CD.
- Grammar Made Easy by Darling Kindersley.
- Punctuation Made Easy by Darling Kindersley.
- Oxford Advanced Learner's Compass, 10<sup>th</sup> Edition.
- English in Mind (Series 1-4), Herbert Puchta and Jeff Stranks with Meredith Levy, Cambridge.
- English Pronunciation in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
- English Vocabulary in Use (Elementary, Intermediate, Advanced) Cambridge University Press.
- TOEFL & GRE (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS).
- Digital All
- Orell Digital Language Lab (Licensed Version)

#### REFERENCE BOOKS:

1. (2022). *English Language Communication Skills – Lab Manual cum Workbook*. Cengage Learning India Pvt. Ltd.
2. Shobha, KN & Rayen, J. Lourdes. (2019). *Communicative English – A workbook*. Cambridge University Press
3. Kumar, Sanjay & Lata, Pushp. (2019). *Communication Skills: A Workbook*. Oxford University Press
4. Board of Editors. (2016). *ELCS Lab Manual: A Workbook for CALL and ICS Lab Activities*. Orient Black Swan Pvt. Ltd.
5. Mishra, Veerendra et al. (2020). *English Language Skills: A Practical Approach*. Cambridge University Press



## List of Equipments

### ENGLISH LANGUAGE COMMUNICATION SKILLS LAB.

Sl.no	Name of the Equipment
1	Platform Software (Walden Software)
2	Master Console
3	Student Console
4	Multimedia Computers
5	Head Phones
6	Learning Software (Walden Software)
7	Public Address System
8	TV
9	Projector
10	Digital Stereo-Audio and Video System
11	Camcorder



## C PROGRAMMING AND DATA STRUCTURES LABORATORY- CS109ES

**B.Tech. I Year I Sem.**

**L T P C**  
**0 0 2 1**

**Course Objectives:** Introduce the importance of programming, C language constructs, program development, data structures, searching and sorting.

### Course Outcomes:

1. Develop modular and readable C Programs
2. Solve problems using strings, functions
3. Handle data in files
4. Implement stacks, queues using arrays, linked lists.
5. To understand and analyze various searching and sorting algorithms

### List of Experiments:

1. Write a C program to find the sum of individual digits of a positive integer.
2. Fibonacci sequence is defined as follows: the first and second terms in the sequence are 0 and 1. Subsequent terms are found by adding the preceding two terms in the sequence. Write a C program to generate the first n terms of the sequence.
3. Write a C program to generate all the prime numbers between 1 and n, where n is a value supplied by the user.
4. Write a C program to find the roots of a quadratic equation.
5. Write a C program to find the factorial of a given integer.
6. Write a C program to find the GCD (greatest common divisor) of two given integers.
7. Write a C program to solve Towers of Hanoi problem.
8. Write a C program, which takes two integer operands and one operator from the user, performs the operation and then prints the result. (Consider the operators +, -, \*, /, % and use Switch Statement)
9. Write a C program to find both the largest and smallest number in a list of integers.
10. Write a C program that uses functions to perform the following:
  - i) Addition of Two Matrices
  - ii) Multiplication of Two Matrices
11. Write a C program that uses functions to perform the following operations:
  - i) To insert a sub-string in to a given main string from a given position.
  - ii) To delete n Characters from a given position in a given string.
12. Write a C program to determine if the given string is a palindrome or not
13. Write a C program that displays the position or index in the string S where the string T begins, or - 1 if S doesn't contain T.
14. Write a C program to count the lines, words and characters in a given text.
15. Write a C program to generate Pascal's triangle.
16. Write a C program to construct a pyramid of numbers.
17. 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(Note: represent complex number using a structure.)
18.
  - i. Write a C program which copies one file to another.
  - ii. Write a C program to reverse the first n characters in a file.  
(Note: The file name and n are specified on the command line.)
19.
  - i. Write a C program to display the contents of a file.



- ii. Write a C program to merge two files into a third file (i.e., the contents of the first file followed by those of the second are put in the third file)
20. Write a C program that uses functions to perform the following operations on singly linked list.:
- i) Creation                      ii) Insertion                      iii) Deletion                      iv) Traversal
21. Write C programs that implement stack (its operations) using
- i) Arrays                      ii) Pointers
22. Write C programs that implement Queue (its operations) using
- i) Arrays                      ii) Pointers
23. Write a C program that implements the following sorting methods to sort a given list of integers in ascending order      i) Bubble sort      ii) Selection sort      iii) Insertion sort
24. Write C programs that use both recursive and non recursive functions to perform the following searching operations for a Key value in a given list of integers:
- i) Linear search                      ii) Binary search

**TEXT BOOKS:**

1. C Programming & Data Structures, B.A. Forouzan and R. F. Gilberg, Third Edition, Cengage Learning.
2. Let us C, Yeswanth Kanitkar
3. C Programming, Balaguruswamy.

**Lab Equipment:**

Computer systems with C compiler installed





## ENVIRONMENTAL SCIENCE- MC110ES

B.Tech. I Year I Sem.

L T P C  
3 0 0 0

### Course Objectives:

- Understanding the importance of ecological balance for sustainable development.
- Understanding the impacts of developmental activities and mitigation measures.
- Understanding the environmental policies and regulations

### Course Outcomes:

- Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

### UNIT - I

**Ecosystems:** Definition, Scope, and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

### UNIT - II

**Natural Resources: Classification of Resources:** Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and using mineral resources, **Land resources:** Forest resources, **Energy resources:** growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

### UNIT - III

**Biodiversity and Biotic Resources:** Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

### UNIT - IV

**Environmental Pollution and Control Technologies: Environmental Pollution:** Classification of pollution, **Air Pollution:** Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Noise Pollution:** Sources and Health hazards, standards, **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary. Overview of air pollution control technologies, Concepts of bioremediation. **Global Environmental Issues and Global Efforts:** Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol. NAPCC-Gol Initiatives.

### UNIT - V

**Environmental Policy, Legislation & EIA:** Environmental Protection act, Legal aspects Air Act-1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-economical aspects. Strategies for risk assessment, Concepts of Environmental



Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development Goals, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

**TEXT BOOKS:**

- 1 Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
- 2 Environmental Studies by R. Rajagopalan, Oxford University Press.

**REFERENCE BOOKS:**

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
4. Environmental Studies by Anubha Kaushik, 4<sup>th</sup> Edition, New age international publishers.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BS Publications.
6. Introduction to Environmental Science by Y. Anjaneyulu, BS. Publications.



## ORDINARY DIFFERENTIAL EQUATIONS AND VECTOR CALCULUS- MA201BS

**B.Tech. I Year II Sem.**

**L T P C**  
**3 1 0 4**

**Pre-requisites:** Mathematical Knowledge at pre-university level

**Course Objectives:** To learn

- Methods of solving the differential equations of first and higher order.
- Concept, properties of Laplace transforms
- Solving ordinary differential equations using Laplace transforms techniques.
- The physical quantities involved in engineering field related to vector valued functions
- The basic properties of vector valued functions and their applications to line, surface and volume integrals

**Course outcomes:** After learning the contents of this paper the student must be able to

- Identify whether the given differential equation of first order is exact or not
- Solve higher differential equation and apply the concept of differential equation to real world problems.
- Use the Laplace transforms techniques for solving ODE's.
- Evaluate the line, surface and volume integrals and converting them from one to another

### **UNIT-I: First Order ODE**

**8 L**

Exact differential equations, Equations reducible to exact differential equations, linear and Bernoulli's equations, Orthogonal Trajectories (only in Cartesian Coordinates). Applications: Newton's law of cooling, Law of natural growth and decay.

### **UNIT-II: Ordinary Differential Equations of Higher Order**

**10 L**

Second order linear differential equations with constant coefficients: Non-Homogeneous terms of the type  $e^{ax}$ ,  $\sin ax$ ,  $\cos ax$ , polynomials in  $x$ ,  $e^{ax}V(x)$  and  $x V(x)$ , method of variation of parameters, Equations reducible to linear ODE with constant coefficients: Legendre's equation, Cauchy-Euler equation. Applications: Electric Circuits

### **UNIT-III: Laplace transforms**

**10 L**

Laplace Transforms: Laplace Transform of standard functions, First shifting theorem, Second shifting theorem, Unit step function, Dirac delta function, Laplace transforms of functions when they are multiplied and divided by 't', Laplace transforms of derivatives and integrals of function, Evaluation of integrals by Laplace transforms, Laplace transform of periodic functions, Inverse Laplace transform by different methods, convolution theorem (without proof). Applications: solving Initial value problems by Laplace Transform method.

### **UNIT-IV: Vector Differentiation**

**10 L**

Vector point functions and scalar point functions, Gradient, Divergence and Curl, Directional derivatives, Tangent plane and normal line, Vector Identities, Scalar potential functions, Solenoidal and Irrotational vectors.

### **UNIT-V: Vector Integration**

**10 L**

Line, Surface and Volume Integrals, Theorems of Green, Gauss and Stokes (without proofs) and their applications.

### **TEXT BOOKS:**

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 36<sup>th</sup> Edition, 2010



2. R.K. Jain and S.R.K. Iyengar, Advanced Engineering Mathematics, Narosa Publications, 5<sup>th</sup> Edition, 2016.

**REFERENCE BOOKS:**

1. Erwin Kreyszig, Advanced Engineering Mathematics, 9<sup>th</sup> Edition, John Wiley & Sons, 2006.
2. G.B. Thomas and R.L. Finney, Calculus and Analytic geometry, 9<sup>th</sup> Edition, Pearson, Reprint, 2002.
3. H. K. Dass and Er. Rajnish Verma, Higher Engineering Mathematics, S Chand and Company Limited, New Delhi.
4. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2008.



## ENGINEERING CHEMISTRY- CH202BS

B.Tech. I Year II Sem.

L T P C  
3 1 0 4

### Course Objectives:

1. To bring adaptability to new developments in Engineering Chemistry and to acquire the skills required to become a perfect engineer.
2. To include the importance of water in industrial usage, fundamental aspects of battery chemistry, significance of corrosion it's control to protect the structures.
3. To imbibe the basic concepts of petroleum and its products.
4. To acquire required knowledge about engineering materials like cement, smart materials and Lubricants.

### Course Outcomes:

1. Students will acquire the basic knowledge of electrochemical procedures related to corrosion and its control.
2. The students are able to understand the basic properties of water and its usage in domestic and industrial purposes.
3. They can learn the fundamentals and general properties of polymers and other engineering materials.
4. They can predict potential applications of chemistry and practical utility in order to become good engineers and entrepreneurs.

### UNIT - I: Water and its treatment: [8]

Introduction to hardness of water – Estimation of hardness of water by complexometric method and related numerical problems. Potable water and its specifications - Steps involved in the treatment of potable water - Disinfection of potable water by chlorination and break - point chlorination. Defluoridation - Determination of F<sup>-</sup> ion by ion- selective electrode method.

Boiler troubles: Sludges, Scales and Caustic embrittlement. Internal treatment of Boiler feed water - Calgon conditioning - Phosphate conditioning - Colloidal conditioning, External treatment methods - Softening of water by ion- exchange processes. Desalination of water – Reverse osmosis.

### UNIT – II Battery Chemistry & Corrosion [8]

Introduction - Classification of batteries- primary, secondary and reserve batteries with examples. Basic requirements for commercial batteries. Construction, working and applications of: Zn-air and Lithium ion battery, Applications of Li-ion battery to electrical vehicles. Fuel Cells- Differences between battery and a fuel cell, Construction and applications of Methanol Oxygen fuel cell and Solid oxide fuel cell. Solar cells - Introduction and applications of Solar cells.

**Corrosion:** Causes and effects of corrosion – theories of chemical and electrochemical corrosion – mechanism of electrochemical corrosion, Types of corrosion: Galvanic, water-line and pitting corrosion. Factors affecting rate of corrosion, Corrosion control methods- Cathodic protection – Sacrificial anode and impressed current methods.

### UNIT - III: Polymeric materials: [8]

Definition – Classification of polymers with examples – Types of polymerization – addition (free radical addition) and condensation polymerization with examples – Nylon 6:6, Terylene

**Plastics:** Definition and characteristics- thermoplastic and thermosetting plastics, Preparation, Properties and engineering applications of PVC and Bakelite, Teflon, Fiber reinforced plastics (FRP).

**Rubbers:** Natural rubber and its vulcanization.

**Elastomers:** Characteristics –preparation – properties and applications of Buna-S, Butyl and Thiokol rubber.

**Conducting polymers:** Characteristics and Classification with examples-mechanism of conduction in trans-polyacetylene and applications of conducting polymers.



**Biodegradable polymers:** Concept and advantages - Polylactic acid and poly vinyl alcohol and their applications.

**UNIT - IV: Energy Sources: [8]**

Introduction, Calorific value of fuel – HCV, LCV- Dulong's formula. Classification- solid fuels: coal – analysis of coal – proximate and ultimate analysis and their significance. Liquid fuels – petroleum and its refining, cracking types – moving bed catalytic cracking. Knocking – octane and cetane rating, synthetic petrol - Fischer-Tropsch's process; Gaseous fuels – composition and uses of natural gas, LPG and CNG, Biodiesel – Transesterification, advantages.

**UNIT - V: Engineering Materials: [8]**

**Cement:** Portland cement, its composition, setting and hardening.

**Smart materials and their engineering applications**

Shape memory materials- Poly L- Lactic acid. Thermoresponse materials- Polyacryl amides, Poly vinyl amides

**Lubricants:** Classification of lubricants with examples-characteristics of a good lubricants - mechanism of lubrication (thick film, thin film and extreme pressure)- properties of lubricants: viscosity, cloud point, pour point, flash point and fire point.

**TEXT BOOKS:**

1. Engineering Chemistry by P.C. Jain and M. Jain, Dhanpatrai Publishing Company, 2010
2. Engineering Chemistry by Rama Devi, Venkata Ramana Reddy and Rath, Cengage learning, 2016
3. A text book of Engineering Chemistry by M. Thirumala Chary, E. Laxminarayana and K. Shashikala, Pearson Publications, 2021.
4. Textbook of Engineering Chemistry by Jaya Shree Anireddy, Wiley Publications.

**REFERENCE BOOKS:**

1. Engineering Chemistry by Shikha Agarwal, Cambridge University Press, Delhi (2015)
2. Engineering Chemistry by Shashi Chawla, Dhanpatrai and Company (P) Ltd. Delhi (2011)



## COMPUTER AIDED ENGINEERING GRAPHICS –ME203ES

**B.Tech. I Year II Sem.**

**L T P C**  
**1 0 4 3**

### Course Objectives:

- To develop the ability of visualization of different objects through technical drawings
- To acquire computer drafting skill for communication of concepts, ideas in the design of engineering products

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

- Apply computer aided drafting tools to create 2D and 3D objects
- sketch conics and different types of solids
- Appreciate the need of Sectional views of solids and Development of surfaces of solids
- Read and interpret engineering drawings
- Conversion of orthographic projection into isometric view and vice versa manually and by using computer aided drafting

### UNIT – I:

**Introduction to Engineering Graphics:** Principles of Engineering Graphics and their Significance, Scales – Plain & Diagonal, Conic Sections including the Rectangular Hyperbola – General method only. Cycloid, Epicycloid and Hypocycloid.

### UNIT- II:

**Orthographic Projections:** Principles of Orthographic Projections – Conventions – Projections of Points and Lines, Projections of Plane regular geometric figures.

### UNIT – III:

Projections of Regular Solids – Auxiliary Views - Sections or Sectional views of Right Regular Solids – Prism, Cylinder, Pyramid, Cone.

### UNIT – IV:

Development of Surfaces of Right Regular Solids – Prism, Cylinder, Pyramid and Cone.

### UNIT – V:

**Isometric Projections:** Principles of Isometric Projection – Isometric Scale – Isometric Views – Conventions – Isometric Views of Lines, Plane Figures, Simple and Compound Solids – Isometric Projection of objects having non- isometric lines. Isometric Projection of Spherical Parts. Conversion of Isometric Views to Orthographic Views and Vice-versa –Conventions.

### TEXT BOOKS:

1. Engineering Drawing N.D. Bhatt / Charotar
2. Engineering Drawing and graphics Using AutoCAD Third Edition, T. Jeyapooan, Vikas: S. Chand and company Ltd.

### REFERENCE BOOKS:

1. Engineering Drawing, Basant Agrawal and C M Agrawal, Third Edition McGraw Hill
2. Engineering Graphics and Design, WILEY, Edition 2020
3. Engineering Drawing, M. B. Shah, B.C. Rane / Pearson.
4. Engineering Drawing, N. S. Parthasarathy and Vela Murali, Oxford
5. Computer Aided Engineering Drawing – K Balaveera Reddy et al – CBS Publishers

**Note:** - External examination is conducted in conventional mode and internal evaluation to be done by both conventional as well as using computer aided drafting.

### LAB EQUIPMENTS:

COMPUTER WITH AUTO CAD INSTALLED AND DRAWING HALL WITH DRAWING TABLES



## ENGINEERING MECHANICS- ME204ES

**B.Tech. I Year II Sem.**

**L T P C**  
**3 0 0 3**

**Course Objectives:** The objectives of this course are to

- Explain the resolution of a system of forces, compute their resultant and solve problems using equations of equilibrium
- Perform analysis of bodies lying on rough surfaces.
- Locate the centroid of a body and compute the area moment of inertia and mass moment of inertia of standard and composite sections
- Explain kinetics and kinematics of particles, projectiles, curvilinear motion, centroidal motion and plane motion of rigid bodies.
- Explain the concepts of work-energy method and its applications to translation, rotation and plane motion and the concept of vibrations

**Course Outcomes:** At the end of the course, students will be able to

- CO 1: Determine resultant of forces acting on a body and analyse equilibrium of a body subjected to a system of forces.
- CO 2: Solve problem of bodies subjected to friction.
- CO 3: Find the location of centroid and calculate moment of inertia of a given section.
- CO 4: Understand the kinetics and kinematics of a body undergoing rectilinear, curvilinear, rotatory motion and rigid body motion.
- CO 5: Solve problems using work energy equations for translation, fixed axis rotation and plane motion and solve problems of vibration.

### UNIT - I:

Introduction to Engineering Mechanics - Force Systems: Basic concepts, Particle equilibrium in 2-D & 3-D; Rigid Body equilibrium; System of Forces, Coplanar Concurrent Forces, Components in Space – Resultant- Moment of Forces and its Application; Couples and Resultant of Force System, Equilibrium of System of Forces, Free body diagrams, Equations of Equilibrium of Coplanar Systems and Spatial Systems; Static Indeterminacy

### UNIT - II:

**Friction:** Types of friction, Limiting friction, Laws of Friction, Static and Dynamic Friction; Motion of Bodies, wedge friction, ladder friction, screw jack & differential screw jack;  
**Centroid and Centre of Gravity** -Centroid of Lines, Areas and Volumes from first principle, centroid of composite sections; Centre of Gravity and its implications. – Theorem of Pappus

### UNIT - III:

Area moment of inertia- Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Product of Inertia, Parallel Axis Theorem, Perpendicular Axis Theorem

Mass Moment of Inertia: Moment of Inertia of Masses - Transfer Formula for Mass Moments of Inertia – Mass moment of inertia of composite bodies.

### UNIT - IV:

Review of particle dynamics- Rectilinear motion; Plane curvilinear motion (rectangular, path, and polar coordinates). 3-D curvilinear motion; Relative and constrained motion; Newton's 2nd law (rectangular,path, and polar coordinates). Work-kinetic energy, power, potential energy. Impulse-momentum (linear, angular); Impact (Direct and oblique).





### **UNIT - V:**

Kinetics of Rigid Bodies -Basic terms, general principles in dynamics; Types of motion, Instantaneous centre of rotation in plane motion and simple problems; D' Alembert's principle and its applications in plane motion and connected bodies; Work Energy principle and its application in plane motion of connected bodies; Kinetics of rigid body rotation

### **TEXT BOOKS:**

1. Shames and Rao (2006), Engineering Mechanics, Pearson Education
2. Reddy Vijay Kumar K. and J. Suresh Kumar (2010), Singer's Engineering Mechanics –Statics & Dynamics

### **REFERENCE BOOKS:**

1. Beer F.P & Johnston E.R Jr., Vector Mechanics for Engineers – Statics and Dynamics, McGraw Hill, 12<sup>th</sup> Edition.
2. Dumir P.C, Sengupta, Srinivas, Engineering Mechanics- Universities Press, 2020.
3. Hibbeler R.C, Engineering Mechanics, Pearson, 14<sup>th</sup> Edition.
4. Arshad Noor, Zahid & Goel, Engineering Mechanics, Cambridge University Press, 2018.
5. Khurmi R.S, Khurmi N., Engineering Mechanics, S. Chand, 2020.
6. Basudeb Bhattacharyya, "Engineering Mechanics", Oxford University Press



## ENGINEERING MATERIALS- ME205ES

**B.Tech. I Year II Sem.**

**L T P C**  
**2 0 0 2**

**Course Objectives:** The objectives of this course are to

1. Provide basic understanding of engineering materials, their structure, classification and usage.
2. Introduce the testing methods for various material properties and ASTM standards used in testing.
3. Understand the various materials used in mechanical engineering like metals, ceramics, polymers, composite materials and other new materials.

**COURSE OUTCOMES:** At the end of the course, students will be able to:

1. Classify the various materials that will be essential for the mechanical engineering applications.
2. Express the mechanical properties of metals and their testing procedures.
3. Understand the application of materials and their processing
4. Understand the requirement and need for the development of the new materials.

### UNIT-I:

Classification of Engineering Materials, Ashby chart, Mechanical Properties of Metals and their testing equipment/procedures, ASTM standards for testing, Stress–Strain Behavior of various materials, Sources of Material Data

### UNIT –II:

Metals and Metal Alloys, Classification of Metal Alloys, Classification, composition, properties and usage of Ferrous alloys, steel, HSS, grey cast iron, white cast iron; Classification, composition, properties and usage of Non-ferrous materials, Aluminum, Titanium, Zinc, Copper, Nickel, Cobalt and their alloys

### UNIT –III:

Composites: Definitions, Reinforcements and matrices, Types of reinforcements, Types of matrices, Classification of composites, Properties of composites in comparison with standard materials  
Manufacturing methods: Hand and spray lay - up, injection molding, resin injection, filament winding, pultrusion, centrifugal casting and prepregs.

### UNIT – IV:

Ceramics, Classification of ceramic materials, Crystal Structure, Applications and Properties of Ceramics, Ceramic fabrication techniques, Carbon: Diamond and Graphite.  
Polymer Structures, Chemistry of Polymer Molecules, Classification scheme of polymer molecules, Thermoplastic and Thermosetting Polymers, Characteristics, Applications, and Processing of Polymers, Elastomers.

### UNIT – V:

Materials in nano technology: Semiconductor Nanomaterials (Zinc oxide nano materials, titanium dioxide nanoparticles, Metal nanoparticles, ceramic nano materials metal nano particles (Silver, gold, iron and copper), applications, bio materials and other recent materials

### TEXT BOOKS:

1. George Murray, Charles V. White, Wolfgang Weise, “Introduction to Engineering Materials”, CRC Press, 2007.
2. William. D. Callister, David G. Rethwisch, “Materials Science and Engineering: An Introduction”, John Wiley & Sons, 2018.



#### REFERENCE BOOKS:

1. Myer Kutz, "Mechanical Engineers' Handbook", John Wiley & Sons, 2015.
2. M.A. Shah, K.A. Shah, Nano technology, the science of Small, WILEY, Second Edition, 2019.
3. E. Paul De Garmo, J.T. Black, R.A. Kohler. Materials and Processes in Manufacturing, John Wiley and Sons, Inc., NY, 11 th Edition, 2012.
4. R.J. Crawford, plastics engineering, Pergamon Presss, 2013.
5. Donald R Asklund and Pradeep P Phule "Essentials of Materials Science and Engineering", by Pradeep P. Fulay (Author), Donald R. Askeland, 2013.
6. K. K. Chawala, Cermic Matrix composite Materials, Kluwer Academic Publishers, 2002.



## PYTHON PROGRAMMING LABORATORY- CS206BS

**B.Tech. I Year II Sem.**

**L T P C**  
**0 1 2 2**

### Course Objectives:

- To install and run the Python interpreter
- To learn control structures.
- To Understand Lists, Dictionaries in python
- To Handle Strings and Files in Python

**Course Outcomes:** After completion of the course, the student should be able to

- Develop the application specific codes using python.
- Understand Strings, Lists, Tuples and Dictionaries in Python
- Verify programs using modular approach, file I/O, Python standard library
- Implement Digital Systems using Python

Note: The lab experiments will be like the following experiment examples

### Week -1:

1. i) Use a web browser to go to the Python website <http://python.org>. This page contains information about Python and links to Python-related pages, and it gives you the ability to search the Python documentation.  
ii) Start the Python interpreter and type help() to start the online help utility.
2. Start a Python interpreter and use it as a Calculator.
3.
  - i) Write a program to calculate compound interest when principal, rate and number of periods are given.
  - ii) Given coordinates (x1, y1), (x2, y2) find the distance between two points
4. Read name, address, email and phone number of a person through keyboard and print the details.

### Week - 2:

1. Print the below triangle using for loop.  
5  
4 4  
3 3 3  
2 2 2 2  
1 1 1 1 1
2. Write a program to check whether the given input is digit or lowercase character or uppercase character or a special character (use 'if-else-if' ladder)
3. Python Program to Print the Fibonacci sequence using while loop
4. Python program to print all prime numbers in a given interval (use break)

### Week - 3:

1. i) Write a program to convert a list and tuple into arrays.  
ii) Write a program to find common values between two arrays.
2. Write a function called gcd that takes parameters a and b and returns their greatest common divisor.
3. Write a function called palindrome that takes a string argument and returns True if it is a palindrome and False otherwise. Remember that you can use the built-in function len to check the length of a string.

### Week - 4:

1. Write a function called is\_sorted that takes a list as a parameter and returns True if the list is sorted in ascending order and False otherwise.



2. Write a function called `has_duplicates` that takes a list and returns `True` if there is any element that appears more than once. It should not modify the original list.
  - i). Write a function called `remove_duplicates` that takes a list and returns a new list with only the unique elements from the original. Hint: they don't have to be in the same order.
  - ii). The wordlist I provided, `words.txt`, doesn't contain single letter words. So you might want to add "l", "a", and the empty string.
  - iii). Write a python code to read dictionary values from the user. Construct a function to invert its content. i.e., keys should be values and values should be keys.
3.
  - i) Add a comma between the characters. If the given word is 'Apple', it should become 'A,p,p,l,e'
  - ii) Remove the given word in all the places in a string?
  - iii) Write a function that takes a sentence as an input parameter and replaces the first letter of every word with the corresponding upper case letter and the rest of the letters in the word by corresponding letters in lower case without using a built-in function?
4. Writes a recursive function that generates all binary strings of n-bit length

#### **Week - 5:**

1.
  - i) Write a python program that defines a matrix and prints
  - ii) Write a python program to perform addition of two square matrices
  - iii) Write a python program to perform multiplication of two square matrices
2. How do you make a module? Give an example of construction of a module using different geometrical shapes and operations on them as its functions.
3. Use the structure of exception handling all general purpose exceptions.

#### **Week-6:**

1.
  - a. Write a function called `draw_rectangle` that takes a `Canvas` and a `Rectangle` as arguments and draws a representation of the `Rectangle` on the `Canvas`.
  - b. Add an attribute named `color` to your `Rectangle` objects and modify `draw_rectangle` so that it uses the `color` attribute as the fill color.
  - c. Write a function called `draw_point` that takes a `Canvas` and a `Point` as arguments and draws a representation of the `Point` on the `Canvas`.
  - d. Define a new class called `Circle` with appropriate attributes and instantiate a few `Circle` objects. Write a function called `draw_circle` that draws circles on the canvas.
2. Write a Python program to demonstrate the usage of Method Resolution Order (MRO) in multiple levels of Inheritances.
3. Write a python code to read a phone number and email-id from the user and validate it for correctness.

#### **Week-7**

1. Write a Python code to merge two given file contents into a third file.
2. Write a Python code to open a given file and construct a function to check for given words present in it and display on found.
3. Write a Python code to Read text from a text file, find the word with most number of occurrences
4. Write a function that reads a file `file1` and displays the number of words, number of vowels, blank spaces, lower case letters and uppercase letters.

#### **Week - 8:**

1. Import `numpy`, `Plotpy` and `Scipy` and explore their functionalities.
2. a) Install `NumPy` package with `pip` and explore it.
3. Write a program to implement Digital Logic Gates – AND, OR, NOT, EX-OR
4. Write a program to implement Half Adder, Full Adder, and Parallel Adder
5. Write a GUI program to create a window wizard having two text labels, two text fields and two buttons as `Submit` and `Reset`.



**TEXT BOOKS:**

1. Supercharged Python: Take your code to the next level, Overland
2. Learning Python, Mark Lutz, O'reilly

**REFERENCE BOOKS:**

1. Python Programming: A Modern Approach, Vamsi Kurama, Pearson
2. Python Programming A Modular Approach with Graphics, Database, Mobile, and Web Applications, Sheetal Taneja, Naveen Kumar, Pearson
3. Programming with Python, A User's Book, Michael Dawson, Cengage Learning, India Edition
4. Think Python, Allen Downey, Green Tea Press
5. Core Python Programming, W. Chun, Pearson
6. Introduction to Python, Kenneth A. Lambert, Cengage

**Lab Equipment:**

Computer system with Python installed



## ENGINEERING CHEMISTRY LABORATORY- CH207BS

B.Tech. I Year II Sem.

L	T	P	C
0	0	2	1

**Course Objectives:** The course consists of experiments related to the principles of chemistry required for engineering student. The student will learn:

- Estimation of hardness of water to check its suitability for drinking purpose.
- Students are able to perform estimations of acids and bases using conductometry, potentiometry and pH metry methods.
- Students will learn to prepare polymers such as Bakelite and nylon-6 in the laboratory.
- Students will learn skills related to the lubricant properties such as saponification value, surface tension and viscosity of oils.

**Course Outcomes:** The experiments will make the student gain skills on:

- Determination of parameters like hardness of water and rate of corrosion of mild steel in various conditions.
- Able to perform methods such as conductometry, potentiometry and pH metry in order to find out the concentrations or equivalence points of acids and bases.
- Students are able to prepare polymers like bakelite and nylon-6.
- Estimations saponification value, surface tension and viscosity of lubricant oils.

### List of Experiments:

**I. Volumetric Analysis:** Estimation of Hardness of water by EDTA Complexometry method.

**II. Conductometry:** Estimation of the concentration of an acid by Conductometry.

**III. Potentiometry:** Estimation of the amount of  $\text{Fe}^{+2}$  by Potentiometry.

**IV. pH Metry:** Determination of an acid concentration using pH meter.

### V. Preparations:

1. Preparation of Bakelite.
2. Preparation Nylon – 6.

### VI. Lubricants:

1. Estimation of acid value of given lubricant oil.
2. Estimation of Viscosity of lubricant oil using Ostwald's Viscometer.

**VII. Corrosion:** Determination of rate of corrosion of mild steel in the presence and absence of inhibitor.

### VIII. Virtual lab experiments

1. Construction of Fuel cell and its working.
2. Smart materials for Biomedical applications
3. Batteries for electrical vehicles.
4. Functioning of solar cell and its applications.

### REFERENCE BOOKS:

1. Lab manual for Engineering chemistry by B. Ramadevi and P. Aparna, S Chand Publications, New Delhi (2022)
2. Vogel's text book of practical organic chemistry 5th edition
3. Inorganic Quantitative analysis by A.I. Vogel, ELBS Publications.
4. College Practical Chemistry by V.K. Ahluwalia, Narosa Publications Ltd. New Delhi (2007).



## ENGINEERING CHEMISTRY LAB

### List of Equipment

S.NO	NAME OF EQUIPMENT
1	PIPETTE (20ml)
2	BURRETTTE (250ml)
3	CONICAL FLASK ( 250ml)
4	BEAKERS ( 205ml)
5	STANDARD FLASK
6	FUNNEL
7	OSTWALDS VISCOMETER
8	STALAGMO METER
9	POTENTIOMETER
10	CONDUCTOMETER
11	REAGENT BOTTLES
12	WATER DISTILLATION SET
13	WATERBATH(12HOLE)
14	WATER BATTLES
15	IODINE BLOWERS
16	MAGNETIC STIRRER
17	MEASURING JAR(100ml)
18	MEASURING JAR(10ml)
19	MEASURING JAR(5ml)
20	TLC PLATES( SILICA COATED)
21	TLC CHAMBER
22	STOP CLOCKS
23	DIGITAL/ANALYTICAL BALANCE





## FUELS AND LUBRICANTS LABORATORY- ME208ES

B.Tech. I Year II Sem.

L T P C  
0 0 2 1

**Prerequisite:** Chemistry

**Course Objectives:** To Understand the fuel and lubricants properties.

**Course Outcomes:** At the end of the course, students will be able to

- Find the kinematic viscosity of lubricants and its variation with temperature
- Determine the flash point, fire point, cloud point and pour point of liquid fuels
- Determine the calorific value of solid, liquid and gaseous fuels
- Determination of the dropping point of lubricating grease
- Determination of distillation characteristics of petroleum products

### List of Experiments:

1. Determination of Flash and Fire points of Liquid fuels/Lubricants using: Abels Apparatus
2. Determination of Flash and Fire points of Liquid fuels/Lubricants using: Pensky Martens Apparatus
3. Carbon residue test: Liquid fuels.
4. Determination of Viscosity of Liquid lubricants and Fuels using: Saybolt Viscometer
5. Determination of Viscosity of Liquid lubricants and Fuels using: Redwood Viscometer
6. Determination of Viscosity of Liquid lubricants and Fuels using: Engler Viscometer
7. Determination of Calorific value: of Gaseous fuels using: Junkers Gas Calorimeter.
8. Determination of Calorific value: Solid/Liquid/ fuels using: Bomb Calorimeter.
9. Drop point and Penetration Apparatus for Grease.
10. ASTM Distillation Test Apparatus.
11. Cloud and Pour Point Apparatus.

### List of Equipment

#### FUELS AND LUBRICANTS – LAB

S.No	Name of the Equipment
1	ABELS FLASH & FIRE POINT APPARATUS
2	PENSKY MARTINS FLASH & FIRE POINT APPARATUS
3	CARBON RESIDUE CONDRADSON APPARATUS
4	SAYBOLT VISCO METER
5	REDWOOD VISCO METER 2
6	ENGLERS VISCO METER
7	JUNKERS GAS CALORI METER
8	DIGITAL BOMB CALORI METER
9	GREASE PENETRATION TEST
10	ASTM DISTILATION APPARATUS
11	CLOUD & POUR POINT APPARATUS



## PROBABILITY, STATISTICS & COMPLEX VARIABLES-22MA304

B.Tech. II Year I Sem.

L T P C  
3 1 0 4

**Pre-requisites:** Mathematics courses of first year of study.

**Course Objectives:** To learn

- The ideas of probability and random variables and various discrete and continuous probability distributions and their properties.
- The basic ideas of statistics including measures of central tendency, correlation and regression.
- The statistical methods of studying data samples.
- Differentiation and integration of complex valued functions.
- Evaluation of integrals using Cauchy's integral formula and Cauchy's residue theorem.
- Expansion of complex functions using Taylor's and Laurent's series.

**Course outcomes:** After learning the contents of this paper the student must be able:

- To apply the concept of random variable, Probability, Distribution in the experimental data.
- To apply the concept of Test of Hypothesis to the parametric and non parametric data.
- To analyze the complex function with reference to their analyticity, integration using Cauchy's integral.
- To develop the Taylor's and Laurent's Series expansion of Complex functions.
- To analyze the contour integration of Complex functions using Residue's theorem.

### UNIT-I: Basic Probability

8 L

Probability spaces, conditional probability, independent events, and Baye's theorem.

Random variables: Discrete and continuous random variables, Expectation of Random Variables, Variance of random variables

### UNIT-II: Probability distributions

10 L

Binomial, Poisson, evaluation of statistical parameters for these distributions, Poisson approximation to the binomial distribution, Continuous random variables and their properties, distribution functions and density functions, Normal and exponential, evaluation of statistical parameters for these distributions.

### UNIT-III: Estimation & Tests of Hypotheses

10 L

Introduction, Statistical Inference, Classical Methods of Estimation.: Estimating the Mean, Standard Error of a Point Estimate, Prediction Intervals, Estimating a Proportion for single sample, Difference between Two Means, difference between two proportions for two Samples.

Statistical Hypotheses: General Concepts, Testing a Statistical Hypothesis, Tests Concerning a Single Mean, Tests on Two Means, Test on a Single Proportion, Two Samples: Tests on Two Proportions.

### UNIT-IV: Complex Differentiation

10 L

Limit, Continuity and Differentiation of Complex functions, Analyticity, Cauchy-Riemann equations (Without proof), finding harmonic conjugate, elementary analytic functions (exponential, trigonometric, logarithm) and their properties, Conformal mappings, Mobius transformations.

### UNIT-V: Complex Integration

10 L

Line integral, Cauchy's theorem, Cauchy's Integral formula, Zeros of analytic functions, Singularities, Taylor's series, Laurent's series, Residues, Cauchy Residue theorem (All theorems without Proof).



**TEXT BOOKS:**

1. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, 35<sup>th</sup> Edition, 2010.
2. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, keying Ye, Probability and statistics for engineers and scientists, 9<sup>th</sup> Edition, Pearson Publications.

**REFERENCE BOOKS:**

1. Fundamentals of Mathematical Statistics, Khanna Publications, S. C. Guptha and V. K. Kapoor.
2. Miller and Freund's, Probability and Statistics for Engineers, 8<sup>th</sup> Edition, Pearson Educations.
3. N.P. Bali and Manish Goyal, A text book of Engineering Mathematics, Laxmi Publications, Reprint, 2010.
4. J. W. Brown and R. V. Churchill, Complex Variables and Applications, 7<sup>th</sup> Edition, Mc-Graw Hill, 2004.



## MECHANICS OF SOLIDS-22ME302-PC

B.Tech. II Year I Sem.

L T P C  
3 0 0 3

**Course Pre-Requisites:** Engineering Mechanics

**Course Objectives:** The objectives of this course are to:

1. Understand the concepts of internal forces, moments, stress, strain, and deformation of solids with applications to bars, beams, and columns.
2. Learn the fundamentals of applying equilibrium, compatibility, and force-deformation relationships to structural elements.
3. Study twisting of circular bars and hollow shafts acted on by torsional moments.
4. Define the state of stress at a point on a body and to develop stress transformations.
5. Introduce the concept of theories of elastic failure and their significance in the design.

**Course Outcomes:** At the end of the course, students will be able to:

1. Evaluate the internal forces, moments, stresses, strains, and deformations in structures made of various materials acted on by a variety of loads.
2. Draw axial force, shear force and bending moment diagrams for beams and frames.
3. Develop the Bending and Torsion formula and apply to the design of beams and shafts.
4. Use the stress transformation equations to find the state of stress at a point for various rotated positions of the stress element and display the same in graphical form as Mohr's circle.
5. Understand the different criteria for the safety of the component by applying the theories of elastic failure.

### UNIT – I:

**Simple Stresses & Strains:** Elasticity and plasticity – Types of stresses & strains–Hooke's law–stress – strain diagram for mild steel – Working stress – Factor of safety – Lateral strain, Poisson's ratio & volumetric strain – Elastic moduli & the relationship between them – Bars of varying section – composite bars – Temperature stresses. Strain energy – Resilience – Gradual, sudden, impact and shock loadings.

### UNIT – II:

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

### UNIT – III:

**Flexural Stresses:** Theory of simple bending – Assumptions – Derivation of bending equation:  $M/I = f/y = E/R$  Neutral axis – Determination bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I,T, Angle and Channel sections – Design of simple beam sections.

**Shear Stresses:** Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, T angle sections.

### UNIT – IV:

**Principal Stresses and Strains:** Introduction – Stresses on an inclined section of a bar under axial loading – compound stresses – Normal and tangential stresses on an inclined plane for biaxial stresses – Two perpendicular normal stresses accompanied by a state of simple shear – Mohr's circle of stresses – Principal stresses and strains – Analytical and graphical solutions.

**Columns and Struts:** Euler's Theory-Buckling loads, Limitations of Euler's theory

### UNIT – V:

**Torsion of Circular Shafts:** Theory of pure torsion – Derivation of Torsion equations:  $T/J = q/r = N\theta/L$  – Assumptions made in the theory of pure torsion – Torsional moment of resistance – Polar section modulus – Power transmitted by shafts.

**Thin cylinders:** Thin seamless cylindrical shells-Derivation of formula for longitudinal and circumferential stresses – hoop, longitudinal and volumetric strains-changes in dia, and volume of thin cylinders-thin spherical shells.



**TEXT BOOKS:**

1. Barry J. Goodno and James M. Gere, "Mechanics of Materials" Ninth Edition, Cengage Learning,2018.
2. S. S. Rattan, "Strength of Materials", Second Edition Tata McGraw Hill Education Pvt. Ltd, New Delhi,2011

**REFERENCE BOOKS:**

1. U. C. Jindal, "Strength of Materials", Pearson Education India,2012
2. Egor P. Popov, Toader A. Balan, "Engineering Mechanics of Solids", PHI Learning, 2010
3. G. H. Ryder, "Strength of Materials", Macmillan Long Man Publications, 1961
4. W. A. Nash and M. C. Potter, "Strength of Materials", Fifth Edition, Schaum's Outline Series, 2011



## **METALLURGY & MATERIAL SCIENCE-22ME303-PC**

**B.Tech. II Year I Sem.**

**L T P C**  
**3 0 0 3**

**Course Objectives:** Students will be able to

1. Learn the concepts of metallurgy and materials science in manufacturing processes.
2. Interpret phase diagrams of different alloy systems.
3. Describe the concept of heat treatment and other strengthening mechanisms.

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

1. Memorize the types of Crystal structures and their defects.
2. Learn the necessity of alloying and identify types of alloy phases.
3. Demonstrate importance of critical understanding of heat treatment in achieving required properties.
4. Apply the knowledge of heat treatment to enhance surface properties.
5. Analyze the properties and micro structure of ferrous and non-ferrous alloys.
6. Develop new materials and enhance properties for the advanced applications.

### **UNIT – I**

Crystal Structure: Unit cells, Metallic and Ceramic crystal structures. Imperfection in solids: Point, line, surface and volume defects; dislocations, strengthening mechanisms, slip systems, critical resolved shear stress.

### **UNIT – II**

Hume – Rothery Rules: Alloys, substitutional and interstitial solid solutions- Phase diagrams: Interpretation of binary phase diagrams and microstructure development; eutectic, peritectic, Eutectoid, peritectoid and monotectic reactions. Iron Iron-carbide phase diagram and microstructural aspects of ledeburite, austenite, pearlite, ferrite and cementite.

### **UNIT –III**

Heat treatment of steels: Isothermal transformation diagrams for Fe-C alloys and microstructures development. Martensite, Bainite. Annealing. Normalising, Hardening, Tempering and Spheroidising.

### **UNIT – IV**

Continuous cooling curves and interpretation of final microstructures and properties-Thermo mechanical treatments like austempering, martempering, surface hardening methods like case hardening, carburizing, nitriding, cyaniding, carbo-nitriding, flame and induction hardening, vacuum and plasma hardening

### **UNIT – V**

Alloy steels, properties and applications of stainless steels and tool steels, maraging steels- Types of cast irons (grey, white, malleable and spheroidal graphite cast irons), copper and its alloys (Brass and bronze)- Aluminium and its alloys (Al-Cu Alloys).

### **TEXT BOOKS:**

1. V. Raghavan, "Material Science and Engineering", Prentice Hall of India Private Limited, Fifth Edition.
2. William. D. Callister, David G. Rethwisch, "Materials Science and Engineering: An Introduction", John Wiley & Sons, 2018.
3. SIDNEY H AVNER, Introduction to Physical Metallurgy, McGraw Hill, 2017

### **REFERENCE BOOKS:**

1. Kenneth G. Budinski and Michael K. Budinski, "Engineering Materials", Prentice Hall of India Private Limited, 9<sup>th</sup> Edition, Indian Reprint, 2009.
2. U. C. Jindal, "Engineering Materials and Metallurgy", Pearson, 2011.



## PRODUCTION TECHNOLOGY-22ME304-PC

**B.Tech. II Year I Sem.**

**L T P C**  
**3 0 0 3**

**Pre-requisites:** None

### Course Objectives:

- To expose the students to understand the concept of basic casting processes & furnaces.
- To provide a technical understanding of various joining processes used in the manufacturing industry.
- To impart the students to the concepts of solid-state welding processes.
- To teach the concepts of rolling and various press working operations.
- To provide a technical understanding of different metal forming processes like extrusion, forging and high energy rate forming processes.

**Course Outcomes:** Student will be able to:

- Elaborate the fundamentals of various moulding, casting techniques and furnaces.
- Identify the importance of permanent joining and principle behind different welding processes.
- Explain the concepts of solid-state welding processes
- Understand the concepts of rolling and sheet metal operations in metal working.
- Elaborates the uniqueness of extrusion, forging and high energy rate forming processes in metal working.

### UNIT – I:

**Casting:** Steps involved in making a casting – Advantage of casting and its applications; Patterns - Pattern making, Types, Materials used for patterns, pattern allowances; Properties of moulding methods. Methods of Melting - Crucible melting and cupola operation – Defects in castings; Principles of Gating – Requirements – Types of gates, Design of gating systems – Riser – Function, types of Riser and Riser design. Casting processes – Types – Sand moulding, Centrifugal casting, die-casting, Investment casting, and shell moulding. Solidification of casting-solidification of pure metal, directional solidification. Injection moulding and Blow moulding.

### UNIT – II:

**Welding:** Classification – Types of welds and welded joints and their characteristics, Welding Positions - Gas welding - Types, oxy-fuel gas cutting – standard time and cost calculations. Arc welding, Shielded metal arc welding, submerged arc welding, Resistance welding, Thermit welding.

### UNIT – III:

Inert Gas Welding \_ TIG Welding, MIG welding, Friction welding, Friction Stir Welding, induction welding, explosive welding, Laser Welding; Soldering and Brazing; Heat affected zone in welding. Welding defects – causes and remedies; destructive and non-destructive testing of welds.

### UNIT – IV:

**Hot working, cold working, strain hardening, recovery, recrystallisation and grain growth.**  
**Sheet metal Operations:** Stamping, Blanking and piercing, Coining, Strip layout, Hot and cold spinning – Bending and deep drawing. Rolling fundamentals – theory of rolling, types of Rolling mills and products. Forces in rolling and power requirements. Drawing and its types – wire drawing and Tube drawing – Types of presses and press tools. Forces and power requirement in the above operations.

### UNIT – V:

**Extrusion of Metals:** Basic extrusion process and its characteristics. Hot extrusion and cold extrusion - Forward extrusion and backward extrusion – Impact extrusion – Extruding equipment – Tube extrusion, Hydrostatic extrusion. Forces in extrusion

**Forging Processes:** Forging operations and principles – Tools – Forging methods – Smith forging,



Drop Forging – Roll forging – Forging hammers: Rotary forging – forging defects – cold forging, swaging, Forces in forging operations.

**High Energy Rate Forming Processes:** Principles of Explosive Forming, Electro-hydraulic Forming, Electro-magnetic forming and rubber pad Forming.

**TEXT BOOKS:**

1. Manufacturing Technology / P.N. Rao/ Vol.1 / Mc Graw Hill Education/ 5<sup>th</sup> Edition, 2018.
2. Manufacturing Engineering & Technology / Serope Kalpakjian / Steven R. Schmid / Pearson, 7<sup>th</sup> Edition,2014

**REFERENCE BOOKS:**

1. Production Technology Vol.: 1, WILEY, sreeramulu M, 2018
2. A Text book of Production Technology (Manufacturing Processes) / Dr.P.C. Sharma / S. Chand Publications /1<sup>st</sup> Edition, 2006.
3. Manufacturing processes H. S. Shan, Second Edition, Cambridge University Press, 2017.
4. Production Technology: Manufacturing Processes, Technology and Automation / R. K. Jain /Vol.1/Khanna Publishers /19<sup>th</sup> Edition, 2009.
5. Elements of Workshop Technology/ S.K. Hajra Choudhury, A.K. Hajra Choudhury, Nirjhar Roy/Vol.1/ Media Publishers & Promoters Pvt. Ltd./1<sup>st</sup> Edition,2008.





## THERMODYNAMICS-22ME305-PC

**B.Tech. II Year I Sem.**

**L T P C**  
**3 1 0 4**

**Pre-requisite:** Engineering Chemistry and Physics

**Course Objective:** To understand the treatment of classical Thermodynamics and to apply the First and Second laws of Thermodynamics to engineering applications

**Course Outcomes:** At the end of the course, the student should be able to

1. Understand the basics of Thermodynamics
2. Apply first and second laws of thermodynamics to different systems
3. Determine the feasibility of a process w.r.to entropy changes
4. Apply concepts of thermodynamic property relations to ideal gas and real gases
5. Evaluate performance of power cycles and refrigeration cycles

**Tables/Codes:** Steam Tables and Mollier Chart, Refrigeration Tables

### UNIT – I:

**Introduction: Basic Concepts:** System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Macroscopic and Microscopic viewpoints, Concept of Continuum, Thermodynamic Equilibrium, State, Property, Process, Exact & Inexact Differentials, Cycle – Reversibility – Quasi – static Process, Irreversible Process, Causes of Irreversibility – Energy in State and in Transition, Types, Displacement & Other forms of Work, Heat, Point and Path functions, Zeroth Law of Thermodynamics – Concept of Temperature – Principles of Thermometry – Reference Points – Const. Volume gas Thermometer – Scales of Temperature, Ideal Gas Scale

### UNIT – II:

PMM I - Joule's Experiments – First law of Thermodynamics – Corollaries – First law applied to a Process – applied to a flow system – Steady Flow Energy Equation.

Limitations of the First Law – Thermal Reservoir, Heat Engine, Heat pump, Parameters of performance, Second Law of Thermodynamics, Kelvin-Planck and Clausius Statements and their Equivalence / Corollaries, PMM of Second kind, Carnot's principle, Carnot cycle and its specialties, Thermodynamic scale of Temperature, Clausius Inequality, Entropy, Principle of Entropy Increase – Energy Equation, Availability and Irreversibility – Thermodynamic Potentials, Gibbs and Helmholtz Functions, Maxwell Relations – Elementary Treatment of the Third Law of Thermodynamics

### UNIT – III:

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

Perfect Gas Laws – Equation of State, specific and Universal Gas constants – various Non-flow processes, properties, end states, Heat and Work Transfer, changes in Internal Energy – Throttling and Free Expansion Processes – Flow processes

### UNIT – IV:

Deviations from perfect Gas Model – Vander Waals Equation of State – Compressibility charts – variable specific Heats – Gas Tables

Mixtures of perfect Gases – Mole Fraction, Mass fraction Gravimetric and volumetric Analysis – Dalton's Law of partial pressure, Avogadro's Laws of additive volumes – Mole fraction, Volume fraction and partial pressure, Equivalent Gas const. And Molecular Internal Energy, Enthalpy, sp. Heats and Entropy of Mixture of perfect Gases and Vapour, Atmospheric air - Psychrometric



Properties – Dry bulb Temperature, Wet Bulb Temperature, Dew point Temperature, Thermodynamic Wet Bulb Temperature, Specific Humidity, Relative Humidity, saturated Air, Vapour pressure, Degree of saturation – Adiabatic Saturation, Carrier's Equation – Psychrometric chart.

#### **UNIT – V:**

**Power Cycles:** Otto, Diesel, Dual Combustion cycles, Sterling Cycle, Atkinson Cycle, Ericsson Cycle, Lenoir Cycle – Description and representation on P–V and T-S diagram, Thermal Efficiency, Mean Effective Pressures on Air standard basis – comparison of Cycles, Brayton and Rankine cycles – Performance Evaluation.

**Refrigeration Cycles:** Bell-Coleman cycle, Vapour compression cycle-performance Evaluation.

#### **TEXT BOOKS:**

1. Engineering Thermodynamics / PK Nag / Mc Graw Hill
2. Thermodynamics – An Engineering Approach by Yunus A. Cengel & Michael A. Boles, TMH
3. Fundamentals of Classical Thermodynamics by G. Van Wylan & R.E. Sonntag, John Wiley Pub

#### **REFERENCE BOOKS:**

1. Engineering Thermodynamics by Jones & Dugan, PHI, 2007.
2. Thermodynamics by M. Achutan, PHI, 2<sup>nd</sup> Edition, 2013.
3. Thermodynamics & Heat Engines by R. Yadav, Central Book Depot, Allahabad.
4. Thermodynamics by S.C. Gupta, Pearson Publications.



## PRODUCTION TECHNOLOGY LABORATORY-22ME306-PC

**B.Tech. II Year I Sem.**

**L T P C**  
**0 0 2 1**

**Pre-requisites:** Production Technology

### **Course Objectives:**

1. Know about the basic Physical, Chemical Properties of materials
2. Learn the basic operation of various manufacturing processes
3. Design and fabricate a simple product

**Course Outcomes:** After completion of the course, the student will be able to

1. Analyze the given problem and conducts investigation on the experimental setup.
2. Operate different types of welding machines
3. Perform operations on mechanical press.
4. get familiarity with processing of Plastics.
5. Effectively communicate and explain the experimental analysis.

### **Minimum of 12 Exercises need to be performed**

#### **I. Metal Casting Lab:**

1. Pattern Design and making - for one casting drawing.
2. Sand properties testing - Exercise -for strengths, and permeability – 1
3. Moulding Melting and Casting - 1 Exercise

#### **II. Welding Lab:**

1. ARC Welding Lap & Butt Joint - 2 Exercises
2. Spot Welding - 1 Exercise
3. TIG Welding - 1 Exercise
4. Plasma welding and Brazing - 2 Exercises (Water Plasma Device)

#### **III. Mechanical Press Working:**

1. Blanking & Piercing operation and study of simple, compound and progressive press tool.
2. Hydraulic Press: Deep drawing and extrusion operation.
3. Bending and other operations

#### **IV. Processing of Plastics**

1. Injection Moulding
2. Blow Moulding

### **REFERENCE BOOK:**

1. Dictionary of Mechanical Engineering – G.H.F. Naylor, Jaico Publishing House



## List of Equipment

### Production technology Lab

S.No	Name of the Equipment
1	Crucible furnace
2	Wood turning lathe
3	Sand strength testing machine
4	Permability testing equipment
5	Arc welding machine
6	Spot welding machine
7	Plasma welding machine
8	Injection moulding machine
9	Blow moulding machine
10	Hydraulic press
11	Fly press
12	Tig welding
13	Brazing Process equipment



## MATERIAL SCIENCE & MECHANICS OF SOLIDS LABORATORY-22ME307-PC

**B.Tech. II Year I Sem.**

**L T P C**  
**0 0 2 1**

**Pre-Requisites:** Material Science and Metallurgy

**Course Objective:** The Objective is to make the students to learn the concepts of Metallurgy and Material Science in manufacturing processes, which convert raw materials into useful products. Students will be able to understand basic structure and crystal arrangements of materials and classify and distinguish different microstructures of steels, cast irons and non-ferrous alloys.

**Course Outcomes:** At the end of the lab, the student will be able to

1. Design different crystal structures and their models.
2. Infer the microstructures developed for different ferrous and non-ferrous metals.
3. Correlate the microstructures, properties, performance and processing of alloys.

**List of Experiments:**

1. Preparation and study of crystal models for simple cubic, body centred cubic, face centred cubic and hexagonal close packed structures.
2. Preparation and study of the Microstructure of pure metals like Iron, Cu and Al.
3. Preparation and study of the Microstructure of Mild steels, low carbon steels, high Carbon steels.
4. Study of the Microstructures of Various Cast Irons.
5. Study of the Microstructures of Non-Ferrous alloys. (Al, Cu, Mg)
6. Hardenability of steels by Jominy End Quench Test.

**MECHANICS OF SOLIDS LAB:**

**Course Objectives:** The objective is to learn the fundamental concepts of stress, strain, and deformation of solids with applications to bars, beams, and columns. Detailed study of engineering properties of materials is also of interest. Fundamentals of applying equilibrium, compatibility, and force-deformation relationships to structural elements are emphasized. The students are introduced to advanced concepts of flexibility and stiffness method of structural analysis. The course builds on the fundamental concepts of engineering mechanics course.

**Course Outcomes:** At the end of the lab, the student will be able to:

- Analyze the behavior of the solid bodies subjected to various types of loading.
- Apply knowledge of materials and structural elements to the analysis of simple structures.
- Undertake problem identification, formulation and solution using a range of analytical methods
- Analyze and interpret laboratory data relating to behavior of structures and the materials they are made of, and undertake associated laboratory work individually and in teams.
- Expectation and capacity to undertake lifelong learning.

**List of Experiments:**

1. Direct tension test
2. Bending test on Simple supported beam
3. Bending test on Cantilever beam
4. Torsion test
5. Brinell hardness test/ Rockwell hardness test
6. Test on springs
7. Izod Impact test/ Charpy Impact test
8. Direct compression test.



## List of Equipment

### MATERIAL SCIENCE & MECHANICS OF SOLIDS LABORATORY

S.No	Name of the Equipment
1	Universal Testing Machine
2	Torsion Testing Machine
3	Izod / Charpy Impact test Machine
4	Brinell hardness test Machine
5	Rockwell hardness test Machine
6	Cantilever beam
7	Simple supported beam
8	Spring test machine
9	Jominy End Quench Test.
10	Belt Grinding Machine
11	Dual Disc polishing Machine
12	Microscopes
13	Muffle furnace
14	Samples: Ferrous metals- Mild Steel, Stainless Steel, High carbon steel, Alloy Steel
15	Samples: non Ferrous- Carbon and its alloys, Aluminium and its alloys



## COMPUTER AIDED MACHINE DRAWING-22ME308-PC

**B.Tech. II Year I Sem.**

**L T P C**  
**0 0 2 1**

**Pre-requisites:** Engineering graphics

**Course objectives:** To familiarize with the standard conventions for different materials and machine parts in working drawings. To make part drawings including sectional views for various machine elements. To prepare assembly drawings given the details of part drawings.

### Course Outcomes:

- Preparation of engineering and working drawings with dimensions and bill of material during design and development. Developing assembly drawings using part drawings of machine components.
- Conventional representation of materials, common machine elements and parts such as screws, nuts, bolts, keys, gears, webs, ribs.
- Types of sections – selection of section planes and drawing of sections and auxiliary sectional views. Parts not usually sectioned.
- Methods of dimensioning, general rules for sizes and placement of dimensions for holes, centers, curved and tapered features.
- Title boxes, their size, location and details - common abbreviations and their liberal usage
- Types of Drawings – working drawings for machine parts.

### Drawing of Machine Elements and simple parts

Selection of Views, additional views for the following machine elements and parts with every drawing proportion.

1. Popular forms of Screw threads, bolts, nuts, stud bolts, tap bolts, set screws.
2. Keys, cottered joints and knuckle joint.
3. Rivetted joints
4. Shaft coupling, spigot and socket pipe joint.
5. Journal, pivot and collar and foot step bearings.

### Drawing of Machine Elements: Using Computer aided drafting in addition to manual drawing

### Assembly Drawings:

Drawings of assembled views for the part drawings of the following using conventions and easy drawing proportions.

1. Steam engine parts – stuffing box, cross head, Eccentric.
2. Machine tool parts: Tail stock, Tool Post, Machine Vices.
3. Other machine parts - Screw jack, Connecting rod, Plumber block, Fuel Injector
4. Valves - Steam stop valve, spring loaded safety valve, feed check valve and air cock.

### Assembly Drawings: Using Computer aided drafting in addition to manual drawing

**NOTE:** 1. First angle projection to be adopted.

2. All the drawing components/Assembly to be drawn using any Computer aided drafting package

### TEXT BOOKS:

1. Machine Drawing / N.D. Bhatt / Charotar
2. Machine Drawing with Auto CAD / Goutham Pohit, Goutam Ghosh / Pearson

### REFERENCE BOOKS:

1. Machine Drawing by / Bhattacharyya / Oxford
2. Machine Drawing / Ajeet Singh / Mc Graw Hill

**Note:** - External examination is conducted in conventional mode and internal evaluation to be done by both conventional as well as using computer aided drafting.



## CONSTITUTION OF INDIA-\*22MC310

**B.Tech. II Year I Sem.**

**L T P C**  
**3 0 0 0**

**Course Objectives:** Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

**Course Outcomes:** Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution
- Discuss the passage of the Hindu Code Bill of 1956.

**Unit - 1** History of Making of the Indian Constitution- History of Drafting Committee.

**Unit - 2** Philosophy of the Indian Constitution- Preamble Salient Features

**Unit - 3** Contours of Constitutional Rights & Duties - Fundamental Rights

- Right to Equality
- Right to Freedom
- Right against Exploitation
- Right to Freedom of Religion
- Cultural and Educational Rights
- Right to Constitutional Remedies
- Directive Principles of State Policy
- Fundamental Duties.

**Unit - 4** Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions

**Unit - 5** Local Administration: District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation. Panchayat raj: Introduction, PRI: Zila Panchayat. Elected officials and their roles, CEO ZilaPanchayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy

**Unit - 6** Election Commission: Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women.

**Suggested Reading:**

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.





## BASIC ELECTRICAL AND ELECTRONICS ENGINEERING-22EE401-ES

B.Tech. II Year II Sem.

L T P C  
3 0 0 3

### Course Objectives:

1. To introduce the concepts of electrical circuits and its components
2. To understand magnetic circuits, DC circuits and AC single phase & three phase circuits
3. To study and understand the different types of DC/AC machines and Transformers.
4. To impart the knowledge of various electrical installations.
5. To introduce the concept of power, power factor and its improvement.
6. To introduce the concepts of diodes & transistors, and
7. To impart the knowledge of various configurations, characteristics and applications.

### Course Outcomes:

1. To analyze and solve electrical circuits using network laws and theorems.
2. To understand and analyze basic Electric and Magnetic circuits
3. To study the working principles of Electrical Machines
4. To introduce components of Low Voltage Electrical Installations
5. To identify and characterize diodes and various types of transistors.

### UNIT - I:

**D.C. Circuits:** Electrical circuit elements (R, L and C), voltage and current sources, KVL&KCL, analysis of simple circuits with dc excitation.

**A.C. Circuits:** Representation of sinusoidal waveforms, peak and rms values, phasor representation, real power, reactive power, apparent power, power factor, Analysis of single-phase ac circuits, Three-phase balanced circuits, voltage and current relations in star and delta connections.

### UNIT - II:

**Electrical Installations:** Components of LT Switchgear: Switch Fuse Unit (SFU), MCB, ELCB, MCCB, Types of Wires and Cables, Earthing. Types of Batteries, Important Characteristics for Batteries. Elementary calculations for energy consumption, power factor improvement and battery backup.

### UNIT - III:

**Electrical Machines:** Working principle of Single-phase transformer, equivalent circuit, losses in transformers, efficiency, Construction and working principle of DC generators, EMF equation, working principle of DC motors, Torque equations and Speed control of DC motors, Construction and working principle of Three-phase Induction motor, Torques equations and Speed control of Three-phase induction motor. Construction and working principle of synchronous generators.

### UNIT - IV:

**P-N Junction and Zener Diode:** Principle of Operation Diode equation, Volt-Ampere characteristics, Temperature dependence, Ideal versus practical, Static and dynamic resistances, Equivalent circuit, diode breakdown mechanism, Zener diode characteristics and applications.

**Rectifiers and Filters:** P-N junction as a rectifier - Half Wave Rectifier, Ripple Factor - Full Wave Rectifier, Bridge Rectifier, Harmonic components in Rectifier Circuits, Filters – Inductor Filters, Capacitor Filters.

### UNIT - V:

**Bipolar Junction Transistor (BJT):** Construction, Principle of Operation, Amplifying Action, Common Emitter, Common Base and Common Collector configurations, Comparison of CE, CB and CC configurations. **Field**

**Effect Transistor (FET):** Construction, Principle of Operation, Comparison of BJT and FET.



**TEXT BOOKS:**

1. Basic Electrical and electronics Engineering –M S Sukija TK Nagasarkar Oxford University
2. Basic Electrical and electronics Engineering-D P Kothari. I J Nagarath, McGraw Hill Education

**REFERENCE BOOKS:**

1. Electronic Devices and Circuits – R. L. Boylestad and Louis Nashelsky, PEI/PHI, 9th Ed, 2006.
2. Millman's Electronic Devices and Circuits – J. Millman and C. C. Halkias, Satyabrata Jit, TMH, 2/e, 1998.
3. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6th edition.
4. Linear circuit analysis (time domain phasor and Laplace transform approaches) - 2nd edition by Raymond A. De Carlo and Pen-Min-Lin, Oxford University Press-2004.
5. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
6. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989



## KINEMATICS OF MACHINERY-22ME402-PC

B.Tech. II Year II Sem.

L T P C  
3 0 0 3

**Prerequisites:** Basic principles of Mechanics

**Course Objectives:** The objectives of this course are

1. To introduce the concept of machines, mechanisms and related terminologies and the relative motion, velocity, and accelerations of the various elements in a mechanism.
2. To make the students become familiar with the most commonly used mechanisms such as four bar/slider crank/double slider crank mechanisms and their inversions.
3. To provide an overview of straight-line motion mechanisms, steering mechanisms and Hooke's joint.
4. To familiarize higher pairs like cams and principles of cams design.
5. To understand the kinematic analysis of gears & gear trains.

**Course Outcomes:** At the end of the course, students will be able to:

1. Understand the various elements in mechanism and the inversions of commonly used mechanisms such as four bar, slider crank and double slider crank mechanisms.
2. Draw the velocity and acceleration polygons for a given configuration of a mechanism.
3. Understand the conditions for straight line motion mechanisms, steering mechanism and the usage of Hooke's joint.
4. Draw the displacement diagrams and cam profile diagram for followers executing different types of motions and various configurations of followers.
5. Calculate the number of teeth and velocity ratio required for a given combination of gears.

### UNIT – I:

**Mechanisms:** Elements or Links – Classification – Rigid Link, flexible and fluid link – Types of kinematics pairs – sliding, turning, rolling, screw and spherical pairs – lower and higher pairs – closed and open pairs – constrained motion – completely, partially or successfully and incompletely constrained.

**Mechanism and Machines** – Mobility of Mechanisms: Grubler's criterion, classification of machines – kinematics chain – inversions of mechanism – inversions of quadric cycle chain, single and double slider crank chains, Mechanical Advantage.

### UNIT – II:

**Kinematics:** Velocity and acceleration – Motion of link in machine – Determination of Velocity and acceleration – Graphical method – Application of relative velocity method.

**Plane motion of body:** Instantaneous center of rotation- centrodes and axodes – Three centers in line theorem – Graphical determination of instantaneous center, determination of angular velocity of points and links by instantaneous center method. Kliens construction - Coriolis acceleration - determination of Coriolis component of acceleration

**Analysis of Mechanisms:** Analysis of slider crank chain for displacement- velocity and acceleration of slider – Acceleration diagram for a given mechanism.

### UNIT – III:

**Straight-line motion mechanisms:** Exact and approximate copied and generated types – Peaucellier - Hart - Scott Russel – Grasshopper – Watt -Tchebicheff's and Robert Mechanism - Pantographs

**Steering gears:** Conditions for correct steering – Davis Steering gear, Ackerman's steering gear.

**Hooke's Joint:** Single and double Hooke's joint –velocity ratio – application – problems.



#### **UNIT – IV:**

**Cams:** Definitions of cam and followers – their uses – Types of followers and cams – Terminology – Types of follower motion - Uniform velocity, Simple harmonic motion and uniform acceleration and retardation. Maximum velocity and maximum acceleration during outward and return strokes in the above 3 cases.

**Analysis of motion of followers:** Tangent cam with Roller follower – circular arc cam with straight, concave and convex flanks.

#### **UNIT – V:**

**Gears:** Friction wheels and toothed gears – types – law of gearing, condition for constant velocity ratio for transmission of motion – velocity of sliding

Forms of teeth, cycloidal and involutes profiles – phenomena of interferences – Methods of interference. Condition for minimum number of teeth to avoid interference – expressions for arc of contact and path of contact of Pinion & Gear and Pinion & Rack Arrangements– Introduction to Helical – Bevel and worm gearing

**Gear Trains:** Introduction – Types – Simple – compound and reverted gear trains – Epicyclic gear train. Methods of finding train value or velocity ratio of Epicyclic gear trains. Selection of gear box - Differential gear for an automobile.

#### **TEXT BOOKS:**

1. Rattan, S.S, "Theory of Machines", 4th Edition, Tata McGraw-Hill, 2014.
2. Uicker, J.J., Pennock G.R and Shigley, J.E., "Theory of Machines and Mechanisms", 4 th Edition, Oxford University Press, 2014.

#### **REFERENCE BOOKS:**

1. Sadhu Sigh, "Theory of Machines", Third Edition, Pearson Education, 2012.
2. Thomas Bevan, "Theory of Machines", 3rd Edition, CBS Publishers and Distributors, 2005.
3. Robert L. Norton, "Kinematics and Dynamics of Machinery", Tata McGraw-Hill, 2009.
4. Rao. J.S. and Dukkupati. R.V. "Mechanisms and Machine Theory", Wiley-Eastern Ltd., New Delhi, 1992.



## FLUID MECHANICS & HYDRAULIC MACHINES-22ME403-PC

**B.Tech. II Year II Sem.**

**L T P C**  
**3 0 0 3**

**Course Objectives:** To enable the student:

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:**

1. Able to explain the effect of fluid properties on a flow system.
2. Able to identify type of fluid flow patterns and describe continuity equation.
3. To analyze a variety of practical fluid flow and measuring devices and utilize Fluid Mechanics principles in design.
4. To select and analyze an appropriate turbine with reference to given situation in power plants.
5. To estimate performance parameters of a given Centrifugal and Reciprocating pump.
6. Able to demonstrate boundary layer concepts.

### **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 pressures – measurement of pressure- Piezometer, U-tube and differential manometers. Hydrostatic forces on Plane –Inclined and Curved surfaces, Buoyancy, Condition of Equilibrium for Submerged and Floating Bodies, Centre of Buoyancy, Metacentre–Determination of Metacentric Height

### **UNIT – II:**

**Fluid kinematics:** Stream line, path line and streak lines and stream tube, classification of flows- steady & unsteady, uniform & non-uniform, laminar & turbulent, rotational & irrotational flows-equation of continuity for one dimensional flow and three-dimensional flows.

**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:**

**Boundary Layer Concepts:** Definition, thicknesses, characteristics along thin plate, laminar and turbulent boundary layers (No derivation) boundary layer in transition, separation of boundary layer, submerged objects – drag and lift.

**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: Pitot tube, venturi meter, and orifice meter, Flow nozzle

### **UNIT – IV:**

**Basics of turbo machinery:** Hydrodynamic force of jets on stationary and moving flat, inclined, and curved vanes, jet striking centrally and at tip, velocity diagrams, work done and efficiency, flow over radial vanes.

**Hydraulic Turbines:** Classification of turbines, Heads and efficiencies, 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 – V:**

**Centrifugal pumps:** Classification, working, work done – barometric head- losses and efficiencies  
specific speed- performance characteristic curves, NPSH.

**Reciprocating pumps:** Working, Discharge, slip, indicator diagrams.

#### **TEXT BOOKS:**

1. Hydraulics, Fluid mechanics and Hydraulic Machinery - MODI and SETH, 21<sup>st</sup> Edition, standard Book House.
2. Fluid Mechanics and Hydraulic Machines by Er. R. K. Rajput, S. Chand,2019.

#### **REFERENCE BOOKS:**

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S.K. Kataria & Sons,2018
2. Fluid Mechanics and Machinery by D. Rama Durgaiah, New Age International publishers
3. Hydraulic Machines by T.R.Banga & S.C. Sharma, 7<sup>th</sup> Edition, Khanna Publishers



## IC ENGINES & GAS TURBINES-22ME404-PC

B.Tech. II Year II Sem.

L T P C  
3 0 0 3

**Pre-requisite:** Thermodynamics

### Course Objective:

1. Explain the Components of IC Engines and systems.
2. Analyze the stages of combustion to improve the performance of IC engines with respect to fuel economy and control of emissions in global, environmental and social context.
3. Understand and evaluate the performance analysis of the major components and systems of IC engines and their applications.
4. Explore to the components and working principles of rotary, reciprocating, dynamic and axial compressors.
5. Understand the significance of gas turbines in real context in power generation.

**Course Outcomes:** At the end of the course, the student should be able to

1. Elaborate the working principles of IC Engine systems and its classification.
2. Explore the combustion stages of SI and CI engines, and factors influence for better combustion.
3. Evaluate the testing and performance parameters of IC engines.
4. Explain the function and working principles of rotary, reciprocating, dynamic axial compressors.
5. Understand the working principle of gas turbine and its classification with thermodynamic analysis.

### UNIT – I:

**I.C. Engines:** Classification - Working principles of Four & Two stroke engine, SI & CI engines, Valve and Port Timing Diagrams, Air – Standard, air-fuel and actual cycles - Engine systems – Carburetor and Fuel Injection Systems for SI engines, Fuel injection systems for CI engines, Ignition, Cooling and Lubrication system, Fuel properties and Combustion Stoichiometry.

### UNIT – II:

Normal Combustion and abnormal combustion in SI engines – Importance of flame speed and effect of engine variables – Abnormal combustion, pre-ignition and knocking in SI Engines – Fuel requirements and fuel rating, anti-knock additives – combustion chamber – requirements, types of SI engines.

Four stages of combustion in CI engines – Delay period and its importance – Effect of engine variables – Diesel Knock– Need for air movement, suction, compression and combustion induced turbulence in Diesel engine – open and divided combustion chambers and fuel injection– Diesel fuel requirements and fuel rating

### UNIT – III:

**Testing and Performance:** Parameters of performance - measurement of cylinder pressure, fuel consumption, air intake, exhaust gas composition, Brake power – Determination of frictional losses and indicated power – Performance test – Heat balance sheet and chart

Classification of compressors – Fans, blowers and compressors – positive displacement and dynamic types – reciprocating and rotary types.

**Reciprocating Compressors:** Principle of operation, work required, Isothermal efficiency volumetric efficiency and effect of clearance volume, staged compression, under cooling, saving of work, minimum work condition for staged compression



#### **UNIT – IV:**

**Rotary Compressor (Positive displacement type):** Roots Blower, vane sealed compressor, mechanical details and principle of working – efficiency considerations.

**Dynamic Compressors:** Centrifugal compressors: Mechanical details and principle of operation – velocity and pressure variation. Energy transfer-impeller blade shape-losses, slip factor, power input factor, pressure coefficient and adiabatic coefficient – velocity diagrams – power.

**Axial Flow Compressors:** Mechanical details and principle of operation – velocity triangles and energy transfer per stage degree of reaction, work done factor - isentropic efficiency- pressure rise calculations – Polytropic efficiency.

#### **UNIT – V:**

**Gas Turbines:** Simple Gas Turbine Plant – Ideal Cycle – Closed Cycle and Open Cycle for Gas Turbines, Constant Pressure Cycle, Constant Volume Cycle, Efficiency – Work Ratio and Optimum Pressure Ratio for Simple Gas Turbine Cycle. Parameters of Performance, Actual Cycle.

#### **TEXT BOOKS:**

1. I.C. Engines, V. Ganesan, 4<sup>th</sup> Edition, Mc Graw Hill
2. Thermal Engineering, Mahesh M Rathore, Tata Mc Graw Hill, 2010

#### **REFERENCE BOOKS:**

1. Applied Thermodynamics for Engineering Technologists, Eastop & McConkey, Pearson
2. Fundamentals of Classical Thermodynamics, Vanwylen G.J., Sonntag R.E., Wiley Eastern
3. Internal Combustion Engines Fundamentals, John B. Heywood, McGraw Hill Ed.





## **INSTRUMENTATION AND CONTROL SYSTEMS-22ME405-PC**

**B.Tech. II Year II Sem.**

**L T P C**

**3 0 0 3**

**Prerequisite:** Mathematics-I, Thermodynamics, Basic of Electrical and Electronics Engineering.

### **Course Objectives:**

1. To impart the basic knowledge of the functional blocks of measurement systems.
2. To provide technical understanding of various Temperature and pressure measuring instruments.
3. To expose the students to know the working of various physical variable Level, Flow, Speed and Acceleration measuring instruments.
4. To understand the working of various physical and Electrical variables Stress, Humidity, Force, Torque and Power measuring instruments.
5. To understand the concept of control system and calculate transfer functions of mechanical and translational systems with different techniques.

**Course Outcome:** After completion of the course, the student will be able to:

1. Know the basic knowledge of the functional blocks of measurement systems.
2. Describe the working of various physical variable Temperature and pressure measuring instruments.
3. Explain the working of various physical variable Level, flow, Speed and Acceleration measuring instruments.
4. Understand the working of various physical and Electrical variables Stress, Humidity, Force, Torque and Power measuring instruments.
5. Understand the concept of control system and calculate transfer functions of mechanical and translational systems with different techniques.

### **UNIT – I:**

Definition – Basic principles of measurement – Measurement systems, generalized configuration and functional description of measuring instruments – examples. Static and Dynamic performance characteristics– sources of errors, Classification and elimination of errors. Measurement of Displacement: Theory and construction of various transducers to measure displacement – Using Piezo electric, Inductive, capacitance, resistance, ionization and Photo electric transducers; Calibration procedures.

### **UNIT – II:**

Measurement of Temperature: Various Principles of measurement-Classification: Expansion Type: Bimetallic Strip- Liquid in glass Thermometer; Electrical Resistance Type: Thermistor, Thermocouple, RTD; Radiation Pyrometry: Optical Pyrometer; Changes in Chemical Phase: Fusible Indicators and Liquid crystals. Measurement of Pressure: Different principles used- Classification: Manometers, Dead weight pressure gauge Tester (Piston gauge), Bourdon pressure gauges, Bulk modulus pressure gauges, Bellows, Diaphragm gauges. Low pressure measurement – Thermal conductivity gauges, ionization pressure gauges, McLeod pressure gauge.

### **UNIT – III:**

Measurement of Level: Direct methods – Indirect methods – Capacitive, Radioactive, Ultrasonic, Magnetic, Cryogenic Fuel level indicators –Bubbler level indicators.

Flow measurement: Rotameter, magnetic, Ultrasonic, Turbine flowmeter, Hot – wire anemometer, Laser Doppler Anemometer (LDA).

Measurement of Speed: Mechanical Tachometers, Electrical tachometers, Non-contact type Stroboscope; Measurement of Acceleration and Vibration: Different simple instruments – Principles of



Seismic instruments – Vibrometer and accelerometer using this principle- Piezo electric accelerometer.

#### **UNIT – IV:**

Stress-Strain measurements: Various types of stress and strain measurements –Selection and installation of metallic strain gauges; electrical strain gauge – gauge factor – method of usage of resistance strain gauge for bending, compressive and tensile strains – Temperature compensation techniques, Use of strain gauges for measuring torque, Strain gauge Rosettes.

Measurement of Humidity: Moisture content of gases, Sling Psychrometer, Absorption Psychrometer, Dew point meter. Measurement of Force, Torque and Power- Elastic force meters, load cells, Torsion meters, Dynamometers.

#### **UNIT – V:**

Elements of Control Systems: Introduction, Importance – Classification – Open and closed systems- Servomechanisms – Examples with block diagrams – Temperature, speed and position control systems- Transfer functions- First and Second order mechanical systems

#### **TEXT BOOKS:**

1. Principles of Industrial Instrumentation & Control Systems/Chennakesava R alaavala, - Cengage Learning/1<sup>st</sup> Edition, 2009.
2. Basic Principles – Measurements (Instrumentation) & Control Systems /S. Bhaskar/ Anuradha Publications

#### **REFERENCE BOOKS:**

1. Measurement Systems: Applications & design, E. O. Doebelin, TMH, Tata Mcgraw Hill/6<sup>th</sup> Edition, 2017.
2. Instrumentation, Measurement & Analysis, B.C. Nakra & K.K. Choudhary, TMH, 4<sup>th</sup> Edition, 2016.
3. Experimental Methods for Engineers / Holman
4. Mechanical and Industrial Measurements / R. K. Jain/ Khanna Publishers.
5. Mechanical Measurements / Sirohi and Radhakrishna / New Age International, 3<sup>rd</sup> Edition, 2013.



## **BASIC ELECTRICAL AND ELECTRONICS ENGINEERING LABORATORY-22EE406-ES**

**B.Tech. II Year II Sem.**

**L T P C**  
**0 0 2 1**

**Pre-requisites:** Basic Electrical and Electronics Engineering

**Course Objectives:**

1. To introduce the concepts of electrical circuits and its components
2. To understand magnetic circuits, DC circuits and AC single phase & three phase circuits
3. To study and understand the different types of DC/AC machines and Transformers.
4. To impart the knowledge of various electrical installations.
5. To introduce the concept of power, power factor and its improvement.
6. To introduce the concepts of diodes & transistors, and
7. To impart the knowledge of various configurations, characteristics and applications.

**Course Outcomes:**

1. To analyze and solve electrical circuits using network laws and theorems.
2. To understand and analyze basic Electric and Magnetic circuits
3. To study the working principles of Electrical Machines
4. To introduce components of Low Voltage Electrical Installations
5. To identify and characterize diodes and various types of transistors.

**List of Experiments/ Demonstrations:**

### **PART A: ELECTRICAL**

1. Verification of KVL and KCL
2. Speed control of DC shunt Motor.
3. Measurement of Active and Reactive Power in a balanced Three-phase circuit
4. Performance Characteristics of a Separately Excited DC Shunt Motor
5. Performance Characteristics of a Three-phase Induction Motor
6. No-Load Characteristics of a Three-phase Alternator

### **PART B: ELECTRONICS**

1. Study and operation of  
(i) Multi-meters (ii) Function Generator (iii) Regulated Power Supplies (iv) CRO.
2. PN Junction diode characteristics
3. Zener diode characteristics and Zener as voltage Regulator
4. Input & Output characteristics of Transistor in CB / CE configuration
5. Full Wave Rectifier with & without filters
6. Input and Output characteristics of FET in CS configuration

**TEXT BOOKS:**

1. Basic Electrical and electronics Engineering –M S Sukija TK Nagasarkar Oxford University
2. Basic Electrical and electronics Engineering-D P Kothari. I J Nagarath, McGraw Hill Education

**REFERENCE BOOKS:**

1. Electronic Devices and Circuits – R. L. Boylestead and Louis Nashelsky, PEI/PHI, 9<sup>th</sup> Ed, 2006.
2. Millman's Electronic Devices and Circuits – J. Millman and C. C. Halkias, Satyabrata Jit, TMH, 2/e, 1998.
3. Engineering circuit analysis- by William Hayt and Jack E. Kemmerly, McGraw Hill Company, 6<sup>th</sup> edition.
4. Linear circuit analysis (time domain phasor and Laplace transform approaches) - 2<sup>nd</sup> edition by Raymond A. De Carlo and Pen-Min-Lin, Oxford University Press-2004.
5. Network Theory by N. C. Jagan& C. Lakshminarayana, B.S. Publications.
6. Network Theory by Sudhakar, Shyam Mohan Palli, TMH.
7. L. S. Bobrow, "Fundamentals of Electrical Engineering", Oxford University Press, 2011.
8. E. Hughes, "Electrical and Electronics Technology", Pearson, 2010.
9. V. D. Toro, "Electrical Engineering Fundamentals", Prentice Hall India, 1989



## Basic Electrical and Electronics Engineering Laboratory

### List of Equipments

S.No	Name of equipment
1	Three phase alternator set (415V, 3A, 1500 rpm)
2	Single phase transformer (2kVA, 115 / 230V)
3	Wattmeter (5/10A, 150/300V) UPF
4	Three phase auto transformer (415/0-470V, 20A)
5	Ammeter (0-5/10 A) MI
6	Wattmeter (5/10A, 150/300V) LP
7	Single phase auto transformer (230/0-270V, 10A)
8	Ammeter (0-2 A) MC
9	Three phase induction motor (3.5 kW, 415V, 7.5A, 1440 rpm)
10	Tachometer(0-9999 rpm)
11	Ammeter (0-20A) MC
12	Voltmeter (0-300) MC
13	Rheostats (0-370 $\Omega$ /1.7 A)
14	Voltmeter (0-150/300V) MI
15	Regulated power supply (0-20V/2A)
16	Voltmeter (0-300/600V) MI
17	Ammeter (0-2.5/5 A) MI
18	DC Shunt motor (3 kW, 220 V, 13.6 A, 1500 rpm)



## FLUID MECHANICS & HYDRAULIC MACHINES LABORATORY-22ME407-PC

**B.Tech. II Year II Sem.**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>2</b>	<b>1</b>

### Course Objectives:

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:

1. Able to explain the effect of fluid properties on a flow system.
2. Able to identify type of fluid flow patterns and describe continuity equation.
3. To analyze a variety of practical fluid flow and measuring devices and utilize fluid mechanics principles in design.
4. To select and analyze an appropriate turbine with reference to given situation in power plants.
5. To estimate performance parameters of a given Centrifugal and Reciprocating pump.
6. Able to demonstrate boundary layer concepts

### List of Experiments:

1. Impact of jets on Vanes.
2. Performance Test on Pelton Wheel.
3. Performance Test on Francis Turbine.
4. Performance Test on Kaplan Turbine.
5. Performance Test on Single Stage Centrifugal Pump.
6. Performance Test on Multi Stage Centrifugal Pump.
7. Performance Test on Reciprocating Pump.
8. Calibration of Venturimeter.
9. Calibration of Orifice meter.
10. Determination of friction factor for a given pipe line.
11. Determination of loss of head due to sudden contraction in a pipeline.
12. Verification of Bernoulli's Theorems.
13. Calibration of triangular –Notch and rectangular Notch  
(discharge measuring device in channels)



**DEPARTMENT OF MECHANICAL ENGINEERING**

**FLUID MECHANICS & HYDRAULIC MACHINES LABORATORY LAB**

<b>S.NO</b>	<b>NAME OF THE EQUIPMENT</b>
1	Venturimeter and Orifice Meter
2	Major losses and Minor losses
3	Impact of jet on vanes
4	Bernoulli's Apparatus
5	Single stage Centrifugal Pump
6	Multi stage Centrifugal Pump
7	Reciprocating Pump
8	Pelton wheel turbine
9	Francis turbine
10	Kaplan Turbine



## INSTRUMENTATION AND CONTROL SYSTEMS LABORATORY-22ME408-PC

**B.Tech. II Year II Sem.**

**L T P C**  
**0 0 2 1**

**Pre-requisites:** Basic principles of Instrumentation and control systems

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

1. Characterize and calibrate measuring devices.
2. Identify and analyze errors in measurement.
3. Analyze measured data using regression analysis.
4. Calibration of Pressure Gauges, temperature, LVDT, capacitive transducer, rotameter.

**List of Experiments:**

1. Calibration of Pressure Gauges.
2. Calibration of transducer for temperature measurement.
3. Study and calibration of LVDT transducer for displacement measurement.
4. Calibration of strain gauge for temperature measurement.
5. Calibration of thermocouple for temperature measurement.
6. Calibration of capacitive transducer for angular displacement.
7. Study and calibration of photo and magnetic speed pickups for the measurement of speed.
8. Calibration of resistance temperature detector for temperature measurement.
9. Study and calibration of a rotameter for flow measurement.
10. Study and use of a Seismic pickup for the measurement of vibration amplitude of an engine bed at various loads.
11. Study and calibration of McLeod gauge for low pressure.
12. Measurement and control of Pressure of a process using SCADA system.
13. Measurement and control of level in a tank using capacitive transducer with SCADA.
14. Measurement and control of temperature of a process using resistance temperature detector with SCADA.



## DEPARTMENT OF MECHANICAL ENGINEERING

### INSTRUMENTATION AND CONTROL SYSTEMS LABORATORY

S.NO	NAME OF THE EQUIPMENT
1	Pressure Guage Set Up
2	Transducer Module For Temperature Measurement
3	LVDT TRANSDUCER Setup
4	Strain Gauge Module
5	Thermocouple Module For Temperature Measurement
6	Angle Measurement Module
7	Photo And Magnetic Speed Pickup Module
8	Resistance Temperature Detector Module
9	Rota Meter Apparatus
10	Seismic Pickup Apparatus
11	Mcleod Gauge Apparatus
12	Drawing Tables
13	Charts Of Limits, Fits, Tolerances
14	Charts For Surface Roughness Representation
15	Charts For Assembly/ Dis Assembly Of A Machine Part
16	Representation Of Screw & Welded Joints, Springs, Gears, Electrical Parts, Hydraulic & Pneumatic Circuits - Charts Indicating These Symbols
17	Systems With SCADA Software





## GENDER SENSITIZATION LAB-22MC409

**B.Tech. II Year II Sem.**

**L T P C**  
**0 0 2 0**

### **COURSE DESCRIPTION**

This course offers an introduction to Gender Studies, an interdisciplinary field that asks critical questions about the meanings of sex and gender in society. The primary goal of this course is to familiarize students with key issues, questions and debates in Gender Studies, both historical and contemporary. It draws on multiple disciplines – such as literature, history, economics, psychology, sociology, philosophy, political science, anthropology and media studies – to examine cultural assumptions about sex, gender, and sexuality.

This course integrates analysis of current events through student presentations, aiming to increase awareness of contemporary and historical experiences of women, and of the multiple ways that sex and gender interact with race, class, caste, nationality and other social identities. This course also seeks to build an understanding and initiate and strengthen programmes combating gender-based violence and discrimination. The course also features several exercises and reflective activities designed to examine the concepts of gender, gender-based violence, sexuality, and rights. It will further explore the impact of gender-based violence on education, health and development.

### **Objectives of the Course**

- To develop students' sensibility with regard to issues of gender in contemporary India.
- To provide a critical perspective on the socialization of men and women.
- To introduce students to information about some key biological aspects of genders.
- To expose the students to debates on the politics and economics of work.
- To help students reflect critically on gender violence.
- To expose students to more egalitarian interactions between men and women.

### **Learning Outcomes**

- Students will have developed a better understanding of important issues related to gender in contemporary India.
- Students will be sensitized to basic dimensions of the biological, sociological, psychological and legal aspects of gender. This will be achieved through discussion of materials derived from research, facts, everyday life, literature and film.
- Students will attain a finer grasp of how gender discrimination works in our society and how to counter it.
- Students will acquire insight into the gendered division of labor and its relation to politics and economics.
- Men and women students and professionals will be better equipped to work and live together as equals.
- Students will develop a sense of appreciation of women in all walks of life.
- Through providing accounts of studies and movements as well as the new laws that provide protection and relief to women, the textbook will empower students to understand and respond to gender violence.

### **Unit-I: UNDERSTANDING GENDER**

Introduction: Definition of Gender-Basic Gender Concepts and Terminology-Exploring Attitudestowards Gender-Construction of Gender-Socialization: Making Women, Making



Men

- Preparing for Womanhood. Growing up Male. First lessons in Caste.

### **Unit – II: GENDER ROLES AND RELATIONS**

Two or Many? -Struggles with Discrimination-Gender Roles and Relations-Types of Gender Roles- Gender Roles and Relationships Matrix-Missing Women-Sex Selection and Its Consequences- Declining Sex Ratio. Demographic Consequences-Gender Spectrum: Beyond the Binary

### **Unit – III: GENDER AND LABOUR**

Division and Valuation of Labour-Housework: The Invisible Labor- “My Mother doesn’t Work.” “Share the Load.”-Work: Its Politics and Economics -Fact and Fiction. Unrecognized and Unaccounted work.  
-Gender Development Issues-Gender, Governance and Sustainable Development-Gender and Human Rights-Gender and Mainstreaming

### **Unit – IV: GENDER - BASED VIOLENCE**

The Concept of Violence- Types of Gender-based Violence-Gender-based Violence from a Human Rights Perspective-Sexual Harassment: Say No!-Sexual Harassment, not Eve-teasing- Coping with Everyday Harassment- Further Reading: “*Chupulu*”.  
Domestic Violence: Speaking Out Is Home a Safe Place? -When Women Unite [Film].  
Rebuilding Lives. Thinking about Sexual Violence Blaming the Victim-“I Fought for my Life....”

### **Unit – V: GENDER AND CULTURE**

Gender and Film-Gender and Electronic Media-Gender and Advertisement-Gender and Popular Literature- Gender Development Issues-Gender Issues-Gender Sensitive Language-Gender and Popular Literature - Just Relationships: Being Together as Equals  
Mary Kom and Onler. Love and Acid just do not Mix. Love Letters. Mothers and Fathers. Rosa Parks-The Brave Heart.

**Note:** Since it is Interdisciplinary Course, Resource Persons can be drawn from the fields of English Literature or Sociology or Political Science or any other qualified faculty who has expertise in this field from engineering departments.

- **Classes will consist of a combination of activities: dialogue-based lectures, discussions, collaborative learning activities, group work and in-class assignments. Apart from the above prescribed book, Teachers can make use of any authentic materials related to the topics given in the syllabus on “Gender”.**

□ **ESSENTIAL READING:** The Textbook, “*Towards a World of Equals: A Bilingual Textbook on Gender*” written by A.Suneetha, Uma Bhrugubanda, Duggirala Vasanta, Rama Melkote, Vasudha Nagaraj, Asma Rasheed, Gogu Shyamala, Deepa Sreenivas and Susie Tharu published by Telugu Akademi, Telangana Government in 2015.



**ASSESSMENT AND GRADING:**

- Discussion & Classroom Participation: 20%
- Project/Assignment: 30%
- End Term Exam: 50%

**22ME501-PC: DYNAMICS OF MACHINERY**

**B.Tech. III Year, I Sem.**

L	T	P	C
3	0	0	3

**Pre-requisite:** Kinematics of Machinery

**Course Objectives:**

- To study the inertia forces, torques and energy involved in different machine members
- To learn the theory involved in the analysis of clutches, brakes, dynamometers, governors and flywheels
- To Understand the balancing of reciprocating and rotary parts
- To be Aware of situations like speed fluctuations, rotor imbalance and machine vibrations in industries
- To Understand the importance of resonance and critical speed

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

- Analyze the effect of a gyroscope on ships, aeroplanes and automobile
- Explain the inertia forces in the working of important machine elements like flywheels, connecting rod etc.
- Understand the types of brakes and the roll of friction
- Understand the working of governors and estimate the unbalanced forces in a multi-cylinder reciprocating engine
- Estimate the longitudinal, transverse and torsional vibrations so as to avoid resonance

**UNIT – I:**

**Precession:** Gyroscopes – effect of precession – motion on the stability of moving vehicles such as motorcycle – motorcar – aeroplanes and ships.

**Static and Dynamic Force Analysis:** Static force analysis of planar mechanisms – Analytical Method – Dynamic Force Analysis – D’Alembert’s principle, Dynamic Analysis of 4-link mechanism, Slider Crank Mechanism.

**UNIT – II:**

**Turning Moment Diagram and Flywheels:** Engine Force Analysis – Piston Effort, Crank



Effort, etc., Inertia Force in Reciprocating Engine – Graphical Method - Turning moment diagram –fluctuation of energy – flywheels and their design - Inertia of connecting rod-inertia force in reciprocating engines – crank effort and torque diagrams.-.

### **UNIT – III:**

**Friction:** pivots and collars – uniform pressure, uniform wear – friction circle and friction axis: lubricated surfaces – boundary friction – film lubrication. Clutches – Types – Single plate, multi-plate and cone clutches. **Brakes and Dynamometers:** Types of brakes: Simple block brake, band and block brake- internal expanding shoe brake-effect of braking of a vehicle. Dynamometers – absorption and transmission types. General description and methods of operation.

### **UNIT – IV:**

**Governors:** Types of governors - Watt, Porter and Proell governors. Spring loaded governors — Hartnell and Hartung with auxiliary springs. Sensitiveness, isochronisms and hunting – stability – effort and power of the governors.

**Balancing:** Balancing of rotating masses- Primary, Secondary, and higher balancing of reciprocating masses. Analytical and graphical methods. Unbalanced forces and couples. Examination of “V” and multi cylinder in-line and radial engines for primary and secondary balancing- locomotive balancing – Hammer blow – Swaying couple – variation of tractive effort.

### **UNIT – V:**

**Vibrations:** Free Vibration of mass attached to vertical spring- Damped free vibrations– Transverse loads – vibrations of beams with concentrated and distributed loads. Dunkerly’s method – Raleigh’s method. Whirling of shafts – critical speed – torsional vibrations – one, two and three rotor systems.

### **TEXT BOOKS:**

1. Theory of Machines, S. S. Rattan, Mc Graw Hill, 2017
2. Theory of Machines /Sadhu Singh/ Pearson.

### **REFERENCE BOOKS:**

1. Theory of Machines and Mechanisms, Joseph E. Shigley, Fifth Edition, Oxford University Press
2. Mechanism and Machine Theory, Rao, J.S & R.V. Duggipati, New Age
3. Bansal R.K, Brar J.S, Theory of Machines, Lakshmi Publications (P) Ltd, 2016 Edition



## 22ME502-PC: DESIGN OF MACHINE ELEMENTS

B.Tech. III Year, I Sem.

L	T	P	C
3	0	0	3

**Note:** Design Data books are not permitted in the Examinations. The design must not only satisfy strength criteria but also rigidity criteria.

**Pre-requisites:** Engineering mechanics, mechanics of solids, manufacturing processes, metallurgy and material science.

### Course Objectives:

- To understand the general design procedures and principles in the design of machine elements.
- To study different materials of construction and their properties and factors determining the selection of material for various applications.
- To determine stresses under different loading conditions.
- To learn the design procedure of different fasteners, joints, shafts and couplings.

### Course Outcomes:

- The student acquires the knowledge about the principles of design, material selection, component behavior subjected to loads, and criteria of failure.
- Understands the concepts of principal stresses, stress concentration in machine members and fatigue loading.
- Design on the basis of strength and rigidity and analyze the stresses and strains induced in a machine element.

### UNIT – I:

**Introduction:** General considerations in the design of Engineering Materials and their properties – selection – Manufacturing consideration in design. Tolerances and fits – BIS codes of steels.

**Design for Static Strength:** Simple stresses – Combined stresses – Torsional and Bending stresses – Impact stresses – Stress strain relation – Various theories of failure – Factor of safety – Design for strength and rigidity – preferred numbers. The concept of stiffness in tension, bending, torsion and combined situations.

### UNIT – II:

**Design for Fatigue Strength:** Stress concentration – Theoretical stress Concentration factor – Fatigue stress concentration factor – Notch Sensitivity – Design for fluctuating stresses – Endurance limit – Estimation of Endurance strength – Gerber's curve – Goodman's line – Soderberg's line.

### UNIT – III:

**Riveted, Welded and Bolted Joints:** Riveted joints- methods of failure of riveted joints-strength equations-efficiency of riveted joints-eccentrically loaded riveted joints.

Welded joints-Design of fillet welds-axial loads-circular fillet welds under bending, torsion.

Welded joints under eccentric loading.

Bolted joints – Design of bolts with pre-stresses – Design of joints under eccentric loading – locking devices – bolts of uniform strength.



#### **UNIT – IV:**

**Keys, Cotters and Knuckle Joints:** Design of keys-stresses in keys-cottered joints-spigot and socket, sleeve and cotter, Gib and cotter joints-Knuckle joints.

#### **UNIT – V:**

**Shafts:** Design of solid and hollow shafts for strength and rigidity – Design of shafts for combined bending and axial loads – Shaft sizes – BIS code. - Gaskets and seals (stationary & rotary)

**Shaft Couplings:** Rigid couplings – Muff, Split muff and Flange couplings. Flexible couplings – Flange coupling (Modified).

#### **TEXT BOOKS:**

1. Design of Machine Elements, V B Bhandari, Fifth Edition, McGraw-Hill
2. Machine Design, Jindal, Pearson

#### **REFERENCE BOOKS:**

1. Design of Machine Elements, V. M. Faires, Macmillan.
2. Design of Machine Elements-I, Annaiah, M.H, New Age International Publishers

## 22ME503 (PC): METROLOGY & MACHINE TOOLS

B.Tech. III Year I Sem.

L	T	P	C
3	0	0	3

### Course Objectives:

- To impart the fundamental aspects of the metal cutting principles and their application in studying the behavior of various machining processes.
- To train in knowing the fundamental parts of various machine tools and their kinematic schemes.
- To improve problem solving skills by determining the machining time of various machining processes.
- To provide technical understanding of basic concepts of engineering metrology and its practice in the industry.
- To make the student to improve applications aspect in the measurements and control of a process in manufacturing.

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

- Explain the principles of metal cutting and working of lathe machine tools.
- Understand working of drilling, boring, shaping, slotting, planing machine tools and estimation of machining time.
- Describe the Principles of working and operations performed on milling and grinding machines.
- Explain the use of various measuring instruments, gauges and system of limits, fits and tolerances.
- Describe the process of measuring the surface roughness, screw thread parameters & principles of coordinate measuring machines.

### UNIT – I:

Metal cutting: Introduction, elements of cutting process – Geometry of single point tool, Chip formation and types of chips, tool materials, tool life, tool wear, cutting fluids, Analysis of orthogonal cutting- Merchant's force diagram, Machinability.

Engine lathe – Principle of working, types of lathes, specifications, operations on lathe, Taper turning methods, Lathe attachments. Capstan and Turret lathe – Single spindle and multi-spindle automatic lathes – tool layouts.

### UNIT – II:

Drilling and Boring Machines – Geometry of twist drill, Principles of working, specifications, types, operations performed, machining time calculations, Types of Boring machines and applications. Shaping, slotting and planing machines – Principles of working, specifications, types of operations performed, applications, quick return mechanisms, machining time calculations.

### UNIT – III:

Milling machines – Principles of working – Types of milling machines – Geometry of milling cutters methods of indexing. Grinding – theory of grinding – classification of grinding machines. Types of abrasives, bonds. Selection of a grinding wheel. Lapping, honing and broaching machines, comparison and Constructional features, machining time calculations

#### **UNIT – IV:**

**Introduction to Metrology:** Need, Types, Terminology, Methods of measurements, Selection of measuring Instruments Linear Measurement: Line and end standard, slip gauges, micrometers, spirit level.

**Limits, fits and tolerances-** Types of Fits - Unilateral and bilateral tolerance system, hole and shaftbasis system. Interchangeability and selective assembly.

**Limit Gauges:** Taylor's principle, Design of GO and NO-GO gauges.

Measurement of angles using Bevel protractor and Sine bar. Measurement of flatness using straightedges, surface plates, optical flat and auto collimator.

#### **UNIT – V:**

Surface Roughness Measurement: Factors affecting the surface roughness, reasons for controlling the surface texture, elements of surface texture-Roughness, Waviness, evaluation of surface roughness-CLA, RMS, Rz Values. Methods of measurement of surface finish, Talysurf. Screw threadmeasurement, Gear measurement; Machine Tool Alignment Tests on lathe, milling and drilling machines. Coordinate Measuring Machines: Types and Applications of CMM.

#### **TEXT BOOKS:**

1. Machine Tool Practices/ Kibbe, John. Neely, T. White, Rolando O. Meyer/ Pearson
2. Engineering Metrology/ R.K. Jain/ Khanna Publishers.

#### **REFERENCE BOOKS:**

1. Gupta I.C., Engineering Metrology, Dhanpat Rai Publications (P) Ltd, 2021 Edition.
2. Principles of Machine Tools, Bhattacharyya A and Sen.G.C / New Central Book Agency.
3. Fundamentals of Dimensional Metrology / Connie Dotson / Thomson
4. Fundamentals of Metal Machining and Machine Tools / Geoffrey Boothroyd / McGraw Hill
5. Principles of Engineering Metrology/ Rega Rajendra/ Jaico Publishers.
6. Metrology and Measurement/ Bewoor & Kulkarni/ Tata Mc Graw Hill.



## 22MS504-MS: BUSINESS ECONOMICS & FINANCIAL ANALYSIS

B.Tech. III Year, I Sem.

L	T	P	C
3	0	0	3

**Course Objective:** To learn the basic Business types, impact of the Economy on Business and Firmsspecifically. To analyze the Business from the Financial Perspective.

**Course Outcome:** The students will understand the various Forms of Business and the impact of economic variables on the Business. The Demand, Supply, Production, Cost, Market Structure, Pricing aspects are learnt. The Students can study the firm's financial position by analysing the Financial Statements of a Company.

### **UNIT – I: Introduction to Business and Economics**

**Business:** Structure of Business Firm, Theory of Firm, Types of Business Entities, Limited Liability Companies, Sources of Capital for a Company, Non-Conventional Sources of Finance.

**Economics:** Significance of Economics, Micro and Macro Economic Concepts, Concepts and Importance of National Income, Inflation, Money Supply in Inflation, Business Cycle, Features and Phases of Business Cycle. Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

### **UNIT – II: Demand and Supply Analysis**

**Elasticity of Demand:** Elasticity, Types of Elasticity, Law of Demand, Measurement and Significance of Elasticity of Demand, Factors affecting Elasticity of Demand, Elasticity of Demand in decision making, Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting.

**Supply Analysis:** Determinants of Supply, Supply Function & Law of Supply.

### **UNIT – III: Production, Cost, Market Structures & Pricing**

**Production Analysis:** Factors of Production, Production Function, Production Function with onevariable input, two variable inputs, Returns to Scale, Different Types of Production Functions.

**Cost analysis:** Types of Costs, Short run and Long run Cost Functions.

**Market Structures:** Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition.

**Pricing:** Types of Pricing, Product Life Cycle based Pricing, Break Even Analysis, Cost Volume Profit Analysis.

**UNIT – IV: Financial Accounting:** Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts.

**UNIT – V: Financial Analysis through Ratios:** Concept of Ratio Analysis, Liquidity Ratios, Turnover Ratios, Profitability Ratios, Proprietary Ratios, Solvency, Leverage Ratios (simple problems). Introduction to Fund Flow and Cash Flow Analysis (simple problems).

**TEXT BOOKS:**

1. D. D. Chaturvedi, S. L. Gupta, Business Economics - Theory and Applications, International Book House Pvt. Ltd. 2013.
2. Dhanesh K Khatri, Financial Accounting, Tata McGraw Hill, 2017.
3. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, Managerial Economics, 2e, Tata McGraw Hill Education Pvt. Ltd. 2017

**REFERENCE BOOKS:**

1. Paresh Shah, Financial Accounting for Management 2e, Oxford University Press, 2019.
2. S. N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.

## 22ME505-PC: STEAM POWER & JET PROPULSION

B.Tech. III Year, I Sem.

L	T	P	C
3	0	0	3

**Note:** Steam Table book Permitted.

**Pre-requisite:** Thermodynamics

**Course Objective:** To apply the laws of Thermodynamics to analyze steam and gas turbine cycles and to perform analysis of the major components of steam and gas turbine plants and their applications.

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

- Develop state – space diagrams based on the schematic diagrams of process flow of steam and gas turbine plants
- Apply the laws of Thermodynamics to analyze thermodynamic cycles
- Differentiate between vapour power cycles and gas power cycles
- Infer from property charts and tables and to apply the data for the evaluation of performance parameters of the steam and gas turbine plants
- Understand the functionality of major components of steam and gas turbine plants and to do the analysis of these components

### UNIT – I:

**Steam Power Plant:** Rankine cycle - Schematic layout, Thermodynamic Analysis, Concept of Mean Temperature of Heat addition, Methods to improve cycle performance – Regeneration & reheating.

**Boilers** – Classification – Working principles with sketches including H.P. Boilers – Mountings and Accessories – Working principles- Boiler horse power, Equivalent Evaporation, Efficiency and Heat balance – Draught- Classification – Height of chimney for given draught and discharge- Condition for maximum discharge- Efficiency of chimney.

### UNIT – II:

**Steam Nozzles:** Stagnation Properties- Function of nozzle – Applications and Types- Flow through nozzles- Thermodynamic analysis – Assumptions -Velocity of nozzle at exit-Ideal and actual expansion in nozzle- Velocity coefficient- Condition for maximum discharge- Critical pressure ratio- Criteria to decide nozzle shape- Super saturated flow, its effects, Degree of super saturation and Degree of undercooling - Wilson line.

### UNIT – III:

**Steam Turbines:** Classification – Impulse turbine; Mechanical details – Velocity diagram – Effect of friction – Power developed, Axial thrust, Blade or diagram efficiency – Condition for maximum efficiency. De-Laval Turbine - its features- Methods to reduce rotor speed-Velocity compounding and Pressure compounding- Velocity and Pressure variation along the flow – Combined velocity diagram for a velocity compounded impulse turbine.

**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 – IV:**

**Steam Condensers:** Requirements of steam condensing plant – Classification of condensers – Working principle of different types – Vacuum efficiency and Condenser efficiency – Air leakage, sources and its affects, Air pump- Cooling water requirement.

**Gas Turbines:** Simple gas turbine plant – Ideal cycle, essential components – Parameters of performance – Regeneration, Inter cooling and Reheating –Closed and Semi-closed cycles – Merits and Demerits- Combustion chambers and turbines of Gas Turbine Plant- Brief Concepts, combined cycle.

**UNIT – V:**

**Jet Propulsion:** Principle of Operation –Classification of jet propulsive engines – Working Principles with schematic diagrams and representation on T-S diagram - Thrust, Thrust Power and Propulsion Efficiency – Turbo jet engines – Needs and Demands met by Turbo jet – Schematic Diagram, Thermodynamic Cycle, Performance Evaluation Thrust Augmentation – Methods.

**Rockets:** Application – Working Principle – Classification – Propellant Type – Thrust, Propulsive Efficiency – Specific Impulse – Solid and Liquid propellant Rocket Engines.

**TEXT BOOKS:**

1. Thermal Engineering / Mahesh M Rathore/ Tata Mc Graw Hill
2. Gas Turbines – V. Ganesan /Tata Mc Graw Hill

**REFERENCE BOOKS:**

1. Gas Turbine Theory/ Saravanamuttoo, Cohen, Rogers, Straznicky, Nix / Pearson
2. Fundamentals of Engineering Thermodynamics / Rathakrishnan/ PHI.
3. Thermal Engineering/ R.K. Rajput/ Lakshmi Publications.

## 22ME506-PC: CAD/CAM

B.Tech. III Year, I Sem.

L	T	P	C
2	0	0	2

**Pre-requisites:** To learn the importance and use of computer in design and manufacture

**Course objectives:** To provide an overview of how computers are being used in design, development of manufacturing plans and manufacture. To understand the need for integration of CAD and CAM

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

- Understand geometric transformation techniques in CAD.
- Develop mathematical models to represent curves and surfaces.
- Model engineering components using solid modeling techniques.
- Develop programs for CNC to manufacture industrial components.
- Understand the application of computers in various aspects of Manufacturing viz., Design, Proper planning, Manufacturing cost, Layout & Material Handling system.

### UNIT – I:

Fundamentals of CAD/ CAM, Application of computers for Design and Manufacturing, Benefits of CAD/CAM - Computer peripherals for CAD/ CAM, Design workstation, Graphic terminal, CAD/ CAM software- definition of system software and application software, CAD/ CAM database and structure. **Geometric Modeling:** Wire frame modeling, wire frame entities, Interpolation and approximation of curves, Concept of parametric and non-parametric representation of curves, Curve fitting techniques, definitions of cubic spline, Bezier, and B-spline.

### UNIT – II:

**Surface modeling:** Algebraic and geometric form, Parametric space of surface, Blending functions, parametrization of surface patch, Subdividing, Cylindrical surface, Ruled surface, Surface of revolution Spherical surface, Composite surface, Bezier surface. B-spline surface, Regenerative surface and pathological conditions.

**Solid Modelling:** Definition of cell composition and spatial occupancy enumeration, Sweep representation, Constructive solid geometry, Boundary representations.

### UNIT – III:

**NC Control Production Systems:** Numerical control, Elements of NC system, NC part programming: Methods of NC part programming, manual part programming, Computer assisted part programming, Post Processor, Computerized part program, SPPL (A Simple Programming Language). CNC, DNC and Adaptive Control Systems.

### UNIT – IV:

**Group Technology:** Part families, Parts classification and coding. Production flow analysis, Machine cell design.

**Computer aided process planning:** Difficulties in traditional process planning, Computer aided process planning: retrieval type and generative type, Machinability data systems.

**Computer aided manufacturing resource planning:** Material resource planning, inputs to MRP, MRP output records, Benefits of MRP, Enterprise resource planning, Capacity requirements planning

**UNIT – V:**

**Flexible manufacturing system:** F.M.S equipment, FMS layouts, Analysis methods for FMS benefits of FMS.

**Computer aided quality control:** Automated inspection- Off-line, On-line, contact, Non-contact; Coordinate measuring machines, Machine vision.

**Computer Integrated Manufacturing:** CIM system, Benefits of CIM

**TEXT BOOKS:**

1. CAD/CAM Concepts and Applications / Alavala / PHI
2. CAD/CAM Principles and Applications / P. N. Rao / Mc Graw Hill
3. CAD/CAM : Computer Aided Design and manufacturing , Groover M.P., Zimmers / Pearson

**REFERENCE BOOKS:**

1. CAD/CAM/CIM/ Radhakrishnan and Subramanyam / New Age

## 22ME507-PC: THERMAL ENGINEERING LAB

B.Tech. III Year, I Sem.

L	T	P	C
0	0	2	1

**Pre-Requisite:** Thermodynamics & Thermal Engineering - I

**Objective:** To understand the working principles of IC Engines, Compressors.

### List of Experiments

1. I.C. Engines Valve / Port Timing Diagrams
2. I.C. Engines Performance Test for 4 Stroke SI engines
3. I.C. Engines Performance Test for 2 Stroke SI engines
4. I.C. Engines Morse, Retardation, Motoring Tests
5. I.C. Engine Heat Balance – CI/SI Engines
6. I.C. Engines Economical speed Test on a SI engine
7. I.C. Engines effect of A/F Ratio in a SI engine
8. Performance Test on Variable Compression Ratio Engine
9. IC engine Performance Test on a 4S CI Engine at constant speed
10. Volumetric efficiency of Air – Compressor Unit
11. Dis-assembly / Assembly of Engines
12. Study of Boilers

**Note:** Perform a minimum of any 10 out of the 12 Exercises.

## 22ME508-PC: METROLOGY & MACHINE TOOLS LAB

B.Tech. III Year, I Sem.

L	T	P	C
0	0	2	1

**Prerequisites:** Theoretical exposure to Metrology and machine tools.

### Course Objectives:

1. To impart practical exposure to the metrology equipment & Machine Tools
2. To conduct experiments and understand the working of the same.

**Course Outcomes:** After completion of the course, the student will be able to

- Identify parts of Lathe and perform different operations on Lathe
- Identify parts of drilling machine and perform operations on drilling machine
- Identify parts of Milling Shaping and Planning machine and perform operations on Milling, Shaping and Planning machine
- Identify various measuring instruments and use them appropriately.
- Measure surface finish of machined components.

### List of Experiments:

1. Step turning on lathe machine
2. Taper turning on lathe machine
3. Thread cutting and knurling on lathe machine (2 exercises)
4. Measurement of cutting forces on lathe
5. Machining of holes using Drilling and boring machines.
6. Gear cutting on the Milling machine
7. Grinding of Tool angles using Cylindrical / Surface Grinding
8. Measurement of lengths, heights, diameters by vernier calipers, micrometers.
9. Measurement of Diameter of bores by internal micrometers and dial bore indicators.
10. Use of gear teeth vernier calipers for checking the chordal addendum and chordal height of the spur gear.
11. Angle and taper measurements by bevel protractor and sine bars.
12. Thread measurement by 2-wire and 3-wire methods.
13. Surface roughness measurement by Tally Surf.
14. Use of mechanical comparator

**Note:** Perform a minimum of any 10 out of the 14 Exercises.



## 22ME509-PC: KINEMATICS & DYNAMICS LAB

B.Tech. III Year, I Sem.

L	T	P	C
0	0	2	1

**Pre-requisites:** Prerequisites for the graduate-level course are Kinematics, Dynamics, differential equations, motion simulation, displacement, velocity, acceleration, force, torque, power, Newton's motion laws, vibration, Gyroscopic Effect, Cams, Bearings.

**Course Objectives:** The objective of the lab is to understand the kinematics and dynamics of mechanical elements such as linkages, gears, cams and learn to design such elements to accomplish desired motions or tasks.

**Course Outcomes:** Upon successful completion of this lab, students should be able to:

- Understand types of motion
- Analyze forces and torques of components in linkages
- Understand static and dynamic balance
- Understand forward and inverse kinematics of open-loop mechanisms

**List of Experiments:** (A Minimum of 10 experiments are to be conducted)

1. To determine the state of balance of machines for primary and secondary forces
2. To determine the frequency of torsional vibration of a given rod
3. Determine the effect of varying mass on the centre of sleeve in porter and proell governor
4. Find the motion of the follower if the given profile of the cam
5. The balance masses statically and dynamically for single rotating mass systems
6. Determine the critical speed of a given shaft for different n-conditions
7. For a simple pendulum determine time period and its natural frequency
8. For a compound pendulum determine time period and its natural frequency
9. Determine the effect of gyroscope for different motions
10. Determine time period, amplitude and frequency of undamped free longitudinal vibration of single degree spring mass systems.
11. Determine the pressure distribution of lubricating oil at various load and speed of a Journal bearing.
12. Determine time period, amplitude and frequency of damped free longitudinal vibration of single degree spring mass systems.

**Note:** Perform a minimum of any 10 out of the 12 Exercises.

## \*22MC510: INTELLECTUAL PROPERTY RIGHTS

B.Tech. III Year, I Sem.

L	T	P	C
3	0	0	0

### Course Objectives:

- Significance of intellectual property and its protection
- Introduce various forms of intellectual property

### Course Outcomes:

- Distinguish and Explain various forms of IPRs.
- Identify criteria to fit one's own intellectual work in particular form of IPRs.
- Apply statutory provisions to protect particular form of IPRs.
- Appraise new developments in IPR laws at national and international level

### UNIT – I

**Introduction to Intellectual property:** Introduction, types of intellectual property, international organizations, agencies and treaties, importance of intellectual property rights.

### UNIT – II

**Trade Marks:** Purpose and function of trademarks, acquisition of trade mark rights, protectable matter, selecting, and evaluating trade mark, trade mark registration processes.

### UNIT – III

**Law of copyrights:** Fundamental of copyright law, originality of material, rights of reproduction, rights to perform the work publicly, copyright ownership issues, copyright registration, notice of copyright, International copyright law.

**Law of patents:** Foundation of patent law, patent searching process, ownership rights and transfer

### UNIT – IV

**Trade Secrets:** Trade secret law, determination of trade secret status, liability for misappropriations of trade secrets, protection for submission, trade secret litigation.

Unfair competition: Misappropriation right of publicity, false advertising.

### UNIT – V

New development of intellectual property: new developments in trade mark law; copyright law, patent law, intellectual property audits.

International overview on intellectual property, international — trade mark law, copyright law, international patent law, and international development in trade secrets law.

### TEXT BOOK:

1. Intellectual property right, Deborah. E. Bouchoux, Cengage learning.

### REFERENCE BOOK:

1. Intellectual property right — Unleashing the knowledge economy, prabuddha ganguli, TataMcGraw Hill Publishing company ltd.

## 22ME601-PC: MACHINE DESIGN

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

**Note:** Design Data Book is permitted. Design of all components should include design for strength and rigidity apart from engineering performance requirements.

**Pre-requisites:** Study of engineering mechanics, design of machine members-I and theory of machines.

### Course objectives:

- To gain knowledge about designing the commonly used important machine members such as bearings, engine parts, springs, belts, gears etc.
- To design the components using the data available in design data books.

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

- Understand the types of bearings, bearing material, bearing design using different empirical relations.
- Estimate the life of rolling element bearings and their selection for given service conditions.
- Design of engine components like piston, connecting rod
- Design of springs, pulleys and belts
- Design of gears

### UNIT – I:

**Sliding contact bearings:** Types of Journal bearings – Lubrication – Bearing Modulus – Full and partial bearings – Clearance ratio – Heat dissipation of bearings, bearing materials – journal bearing design.

### UNIT – II:

**Rolling contact bearings:** Ball and roller bearings – Static load – dynamic load – equivalent radial load – design and selection of ball & roller bearings.

### UNIT – III:

**Engine Parts:** Connecting Rod: Thrust in connecting rod – stress due to whipping action on connecting rod ends – Pistons, Forces acting on piston – Construction, Design and proportions of piston.

### UNIT – IV:

**Mechanical Springs:** Stresses and deflections of helical springs – Extension and compression springs – Design of springs for fatigue loading – natural frequency of helical springs – Energy storage capacity – helical torsion springs – Design of co-axial springs, Design of leaf springs.

**Belts & Pulleys:** Transmission of power by Belt and Rope Drives, Transmission efficiencies, Belts – Flat and V types – Ropes - pulleys for belt and rope drives.

### UNIT – V:

**Gears:** Spur gears & Helical gears- Brief introduction involving important concepts – Design of gears using AGMA procedure involving Lewis and Buckingham equations. Check for wear.

**TEXT BOOKS:**

1. Design of Machine Elements / Spotts/ Pearson
2. Machine Design / Pandya & Shah, 21<sup>st</sup> Edition, 2022 / Charoathar

**REFERENCE BOOKS:**

1. Design of Machine Elements-II / Annaiah, Suresh kumar, chandrappa / New Age
2. Design of Machine Elements / Sharma and Purohit/PHI
3. Design Data Book/ P.V. Ramana Murti & M. Vidyasagar/ B.S. Publications.
4. Design Data Handbook/ S. Md. Jalaludeen/ Anuradha Publishers.

## 22ME602-PC: HEAT TRANSFER

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

**Note:** Heat Transfer Data Book is permitted.

**Pre-requisite:** Thermodynamics

**Course Objectives:** To provide knowledge about application of conduction, convection and radiation heat transfer concepts to different practical applications

**Course Outcome:** At the end of this course, student will be able to

- Understand the basic modes of heat transfer
- Compute one dimensional steady state heat transfer with and without heat generation
- Understand and analyze heat transfer through extended surfaces
- Understand one dimensional transient conduction heat transfer
- Understand concepts of continuity, momentum and energy equations
- Interpret and analyze forced and free convective heat transfer
- Understand the principles of boiling, condensation and radiation heat transfer
- Design of heat exchangers using LMTD and NTU methods

### UNIT – I:

**Introduction:** Modes and mechanisms of heat transfer — Basic laws of heat transfer — General discussion about applications of heat transfer.

**Conduction Heat Transfer:** Fourier rate equation — General heat conduction equation in Cartesian, Cylindrical and Spherical coordinates — simplification and forms of the field equation — steady, unsteady, and periodic heat transfer — Initial and boundary conditions

**One Dimensional Steady State Conduction Heat Transfer:** Homogeneous slabs, hollow cylinders, and spheres- Composite systems– overall heat transfer coefficient — Electrical analogy — Critical radius of insulation

### UNIT – II:

**One Dimensional Steady State Conduction Heat Transfer:** Variable Thermal conductivity — systems with heat sources or Heat Generation-Extended surface (fins) Heat Transfer — Long Fin, Fin with insulated tip and Short Fin, Application to error measurement of Temperature

**One Dimensional Transient Conduction Heat Transfer:** Systems with negligible internal resistance — Significance of Biot and Fourier Numbers — Infinite bodies- Chart solutions of transient conduction systems- Concept of Semi-infinite body.

### UNIT – III:

**Convective Heat Transfer:** Classification of systems based on causation of flow, condition of flow, configuration of flow and medium of flow — Dimensional analysis as a tool for experimental investigation

— Buckingham  $\Pi$  Theorem and method, application for developing semi — empirical non- dimensional correlation for convection heat transfer — Significance of non-dimensional numbers — Concepts of Continuity, Momentum and Energy Equations — Integral Method as approximate method -Application of Von Karman Integral Momentum Equation for flat plate with different velocity profiles.

**Forced convection: External Flows:** Concepts about hydrodynamic and thermal boundary layer and use of empirical correlations for convective heat transfer -Flat plates and Cylinders.

#### **UNIT – IV:**

**Internal Flows:** Concepts about Hydrodynamic and Thermal Entry Lengths – Division of internal flow based on this –Use of empirical relations for Horizontal Pipe Flow and annulus flow.

**Free Convection:** Development of Hydrodynamic and thermal boundary layer along a vertical plate - Use of empirical relations for Vertical plates and pipes.

**Heat Exchangers:** Classification of heat exchangers – overall heat transfer Coefficient and fouling factor – Concepts of LMTD and NTU methods - Problems using LMTD and NTU methods.

#### **UNIT – V:**

**Heat Transfer with Phase Change:**

**Boiling:** Pool boiling – Regimes – Calculations on Nucleate boiling, Critical Heat flux and Film boiling. **Condensation:** Film wise and drop wise condensation –Nusselt's Theory of Condensation on a vertical plate - Film condensation on vertical and horizontal cylinders using empirical correlations.

**Radiation Heat Transfer:** Emission characteristics and laws of black-body radiation – Irradiation – total and monochromatic quantities – laws of Planck, Wien, Kirchoff, Lambert, Stefan and Boltzmann– heat exchange between two black bodies – concepts of shape factor – Emissivity – heat exchange between grey bodies – radiation shields – electrical analogy for radiation networks.

#### **TEXT BOOKS:**

1. Fundamentals of Engineering Heat and Mass Transfer, R.C. Sachdeva, New Age
2. Heat Transfer, J.P. Holman , Tenth Edition, Mc Graw Hill

#### **REFERENCE BOOKS:**

1. Heat Transfer by a Practical Approach, Yunus Cengel, Boles, TMH
2. Heat transfer, A conceptual Approach, P. K. Sarma, Rama Krishna, New Age
3. Heat and mass Transfer, Dr. D. S. Kumar, S. K. Kataria & Sons
4. Essential Heat Transfer - Christopher A Long / Pearson.
5. Heat Transfer –Ghoshdastidar / Oxford.
6. Heat and Mass Transfer data book, CP Kodanda Raman, Subramanyan, New Age

## 22ME603-PC: FINITE ELEMENT METHODS

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

**Pre-requisites:** Mechanics of Solids

**Course Objectives:** The aim of the course is to provide the students.

- Basics of Finite Element Analysis.
- Use of available material models for structural materials, soils and interfaces/joints.
- Modeling of engineering systems and Soil–Structure Interaction (SSI).
- Importance of interfaces and joints on the behavior of engineering systems.
- Implementation of material model in finite element method and applications.

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

- Apply finite element method to solve problems in solid mechanics, fluid mechanics and heat transfer
- Formulate and solve problems in one dimensional structures including trusses, beams and frames.
- Formulate FE characteristic equations for two dimensional elements and analyze plain stress, plain strain, axi-symmetric and plate bending problems.
- Use of ANSYS, ABAQUS, NASTRAN, etc.

### UNIT – I:

Introduction to Finite Element Methods: General Procedure – Engineering Applications – Stress and Equilibrium, Strain – Displacement relations. Stress – strain relations: Finite Elements: 1- Dimensional, 2 – Dimensional, 3-Dimensional & Interpolation Elements

**One Dimensional Problems:** 1-D Linear and 1-D Quadratic Elements - Finite element modeling, Coordinates and shape functions. Assembly of Global stiffness matrix and load vector. Finite element equations, Treatment of boundary conditions, Quadratic shape functions.

### UNIT – II:

**Analysis of Trusses:** Derivation of Stiffness Matrix for Plane Truss, Displacement of Stress Calculations.

**Analysis of Beams:** Element stiffness matrix for two noded, two degrees of freedom per node beam element, Load Vector, Deflection.

### UNIT – III:

Finite element modeling of two-dimensional stress analysis with constant strain triangles and treatment of boundary conditions, Estimation of Load Vector, Stresses

Finite element modeling of Axi-symmetric solids subjected to Axi-symmetric loading with triangular elements. Two dimensional four noded Isoparametric elements and numerical integration.

### UNIT – IV:

**Steady State Heat Transfer Analysis:** one dimensional analysis of Slab, fin and two-dimensional analysis of thin plate.

### UNIT – V:

**Dynamic Analysis:** Formulation of finite element model, element - Mass matrices, evaluation of Eigenvalues and Eigen vectors for a stepped bar, truss and beam.

Finite element — formulation to 3 D problems in stress analysis, convergence requirements, Mesh generation. techniques such as semi-automatic and fully Automatic use of software such as ANSYS, ABAQUS, NASTRAN using Hexahedral and Tetrahedral Elements.

**TEXT BOOKS:**

1. Finite Element Methods: Basic Concepts and applications/Alavala/PHI
2. Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu /Pearson

**REFERENCE BOOKS:**

1. An Introduction to the Finite Element Method / J. N. Reddy/ Mc Graw Hill
2. Finite Element Analysis / SS Bhavikatti / New Age.
3. Finite Element Method/ Dixit/Cengage.



## 22ME61A-PE: UNCONVENTIONAL MACHINING PROCESSES (PROFESSIONAL ELECTIVE – I)

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

**Course Overview:** The objective of this course is to introduce the student to more advanced topics in the machining processes. To bring out the need for Unconventional Machining Processes which will overcome the difficulties associated with Traditional Machining.

### Course Objectives:

- To differentiate conventional and Unconventional Machining Processes and Ultrasonic Machining.
- To understand the process capabilities of abrasive, water jet and electro-chemical machining processes.
- To understand the working principle & important features of electrical discharge machining process.
- To understand the process parameters, accuracy and surface finish of electron beam & laser beam machining Processes.
- To understand the working principle & metal removal rate of plasma arc machining and abrasive finishing process.

**Course Outcomes:** After completion of the course, the student will be able to

- Study the need for unconventional machining processes and explain ultrasonic machining process.
- Describe Abrasive jet, Water jet, and Abrasive water jet machining and electrochemical machining process.
- Describe working principle and process variables of EDM process.
- Explain the process capabilities and process parameters of Electron Beam machining and Laser Beam machining.
- Describe the working of Plasma Arc machining, chemical machining and Abrasive Finishing processes.

### UNIT – I:

**Introduction** – Need for non-traditional machining methods-Classification of modern machining processes – considerations in process selection. Materials. Applications.

Ultrasonic machining – Elements of the process, mechanics of metal removal process, parameters, economic considerations, applications and limitations, recent development.

### UNIT – II:

**Abrasive Jet Machining, Water Jet Machining And Abrasive Water Jet Machining:** Basic principles, equipment, process variable, and mechanics of metal removal, MRR, application and limitations.

**Electro – Chemical Processes:** Fundamentals of electro chemical machining, electrochemical grinding, electro chemical honing and deburring processes, metal removal rate in ECM, Tool design, Surface finish and accuracy, economic aspects of ECM — Simple problems for estimation of metal removal rate.

### UNIT – III:

**Thermal Metal Removal Processes:** General Principle and applications of Electric Discharge Machining, Electric Discharge Grinding and electric discharge wire cutting

processes — Power circuits for EDM, Mechanics of metal removal in EDM, Process parameters, selection of tool electrode and dielectric fluids, methods surface finish and machining accuracy, characteristics of spark eroded surface and machine tool selection. Wire EDM, principle, applications.

**UNIT – IV:**

Generation and control of electron beam for machining, theory of electron beam machining, comparison of thermal and non-thermal processes –General Principle and application of laser beam machining – thermal features, cutting speed and accuracy of cut.

**UNIT – V:**

Application of plasma for machining, metal removing mechanism, process parameters, accuracy and surface finish and other applications of plasma in manufacturing industries. Chemical machining – principle - maskants - applications.

Magnetic abrasive finishing, Abrasive flow finishing, Electro stream drilling, shaped tube electrolyte machining.

**TEXT BOOKS:**

1. Advanced Machining Processes / VK Jain / Allied publishers
2. Modern Machining Processes - P. C. Pandey, H. S. Shan/ Mc Graw Hill

**REFERENCE BOOKS:**

1. Unconventional Manufacturing Processes/ Singh M.K/ New Age Publishers
2. Advanced Methods of Machining/ J.A. McGeough/ Springer International
3. Non-Traditional Manufacturing Processes/ Benedict G.F./ CRC Press

## 22ME61B-PE: PRODUCTION PLANNING & CONTROL (PROFESSIONAL ELECTIVE – I)

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

**Pre-requisites:** Management Science & Productivity.

**Course Objectives:** Understand the importance of Production planning & control. Learning way of carrying out various functions so as to produce right product, right quantity at right time with minimum cost.

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

- Understand production systems and their characteristics.
- Evaluate MRP and JIT systems against traditional inventory control systems.
- Describe and apply methods of line balancing and routing techniques..
- Apply various types of scheduling techniques to production systems.
- Apply dispatching and follow up techniques to the production control and management system.

### UNIT – I:

**Introduction:** Definition – Objectives of Production Planning and Control – Functions of production planning and control - Types of production systems - Organization of production planning and control department.

**Forecasting** – Definition- uses of forecast- factors affecting the forecast- types of forecasting- their uses - general principle of forecasting. Forecasting techniques- quantitative and qualitative techniques. Measures of forecasting errors.

### UNIT – II:

**Inventory management** – Functions of inventories – relevant inventory costs – ABC analysis – VED analysis – Basic EOQ model- Inventory control systems –continuous review systems and periodic review systems, MRP I, MRP II, ERP, JIT Systems - Basic Treatment only. **Aggregate planning** – Definition – aggregate-planning strategies – aggregate planning methods – transportation model.

### UNIT – III:

**Line Balancing:** Terminology, Methods of Line Balancing, RPW method, Largest Candidate method and Heuristic method.

Routing– Definition – Routing procedure – Factors affecting routing procedure, Route Sheet.

### UNIT – IV:

**Scheduling** –Definition – Scheduling Policies – types of scheduling methods – differences with loading

– flow shop scheduling – job shop scheduling, line of balance (LOB) – objectives - steps involved.

### UNIT – V:

**Dispatching:** Definition – activities of dispatcher – dispatching procedures – various forms used in dispatching.

**Follow up:** definition – types of follow up – expediting – definition – expediting procedures- Applications of computers in planning and control.

**TEXT BOOKS:**

1. Operations management/ Heizer/Pearson/13<sup>th</sup> Edition, 2019
2. Production and Operations Management / Ajay K Garg / Mc Graw Hill, 1<sup>st</sup> Edition, 2017

**REFERENCE BOOKS:**

1. Production Planning and Control- Text& cases/ SK Mukhopadhyaya /PHI, 2<sup>nd</sup> Edition, 2007.
2. Production Planning and Control- Jain & Jain – Khanna publications, 8<sup>th</sup> Edition, 1999.

## 22ME61C-PE: OPERATIONS RESEARCH (PROFESSIONAL ELECTIVE – I)

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

**Course Objectives:** To Understand the importance of optimization model and solving it.

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

- Understand the problem, identify the variables & constants
- Formulate the optimization model and apply appropriate optimization technique

### UNIT – I:

Development-definition-characteristics and phases-Types of models-Operations Research models- applications.

**Allocation:** Linear Programming Problem Formulation-Graphical solution- Simplex method-Artificial variable techniques: Two-phase method, Big-M method.

### UNIT – II:

**Transportation problem** - Formulation-Optimal solution, unbalanced transportation problem-Degeneracy.

**Assignment problem**- Formulation-Optimal solution, - Variants of Assignment problem- Travelling salesman problem.

### UNIT – III:

**Sequencing**- Introduction-Flow-Shop sequencing- n jobs through two machines – n jobs through threemachines- Job shop sequencing-two jobs through ‘m’ machines

**Replacement:** Introduction- Replacement of items that deteriorate with time- when money value is not counted and counted- Replacement of items that fail completely- Group Replacement.

### UNIT – IV:

**Theory of Games:** Introduction- Terminology- Solution of games with saddle points and without saddle points. 2 x 2 games- dominance principle- m x 2 & 2 x n games- Graphical method.

**Inventory:** Introduction- Single item, Deterministic models- purchase inventory models with one price break and multiple price breaks- Stochastic models \_ Demand may be discrete variable or continuousvariable- single period model and no setup cost.

### UNIT – V:

**Waiting lines:** Introduction- Terminology- Single channel- Poisson arrivals and Exponential service times with infinite population.

**Dynamic Programming:** Introduction- Terminology, Bellman’s principle of optimality- Applications of Dynamic programming- shortest path problem- linear programming problem.

### TEXT BOOK:

1. Operations Research Theory and Applications / J. K. Sharma sixth Edition, Trinity
2. Introduction to Operations Research/ Hillier & Lieberman/MGH

**REFERENCE BOOKS:**

1. Operations Research: An Introduction, Hamdy A.Taha/PHI
2. Operations Research/NVS Raju/SMS Education/3<sup>rd</sup> Revised Edition
3. Operations Research /A. M. Natarajan, P. Balasubramaniam, A. Tamilarasi/Pearson Education.
4. Operations Research/ Wagner/ PHI Publications.
5. Operations Research/M.V. Durga Prasad, K.Vijaya Kumar Reddy, J. Suresh Kumar/Cengage Learning.

## 22ME61D-PE: MICROPROCESSORS IN AUTOMATION (PROFESSIONAL ELECTIVE – I)

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

### UNIT - I: Basic Concepts of Digital Circuits

Number Systems, Logic Gates, Combinational Circuits, Flip-flops, Sequential Logic Circuits: Counters, Shift Registers.

Basic components and computer architecture- CPU, Memory and Peripherals

### UNIT - II: Architecture of Microprocessor

Introduction, Origin, Historical Developments, Introduction to 8085 Functional Block Diagram, Registers, ALU, Bus Systems, Timing and Control Signals, PIN diagram, Machine Cycles, Instruction Cycle and Timing States, Instruction Timing Diagrams, Addressing Modes. Concept of Interrupt, Need for Interrupts, Interrupt structure, Multiple Interrupt requests and their handling, Programmable interrupt controller

### UNIT - III: Assembly Language Programming

Instruction Set, Simple programs in 8085 mainly on Addition, Subtraction, Multiplication, Rotation, Ascending and Descending of the given data

### UNIT - IV: Memory and I/O Device Interfacing

Memory Interfacing - Memory structure and its requirements, Basic Concept in Memory Interfacing, Address Decoding, Interfacing Circuits, Address Decoding and Memory Addresses, Typical Examples on Memory interfacing: Interface (2k x 8) ROM, (8k x 8) EPROM, and (1k x 8) RAM with 8085.

IO Interfacing – Basic Interfacing Concepts-Peripheral I/O instructions, I/O Execution, Device Selection and data transfer, absolute vs. Partial Decoding, Input Interfacing, Interfacing I/Os using Decoders

### UNIT - V: Architecture of Microcontroller

Introduction to Microcontrollers and how they differ from microprocessors, Block diagram of Microcontrollers, Architecture of 8051 microcontroller, Pin Diagram, Instruction set, simple 8051 programming, introduction to ARM microcontroller and its applications.

### TEXT BOOKS:

1. Microprocessor Architecture, Programming, and Applications with the 8085, Ramesh Gaonkar, PENRAM International Publishers.
2. The 8051 Microcontroller and Embedded Systems: Using Assembly and C, Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D, Mckinlay, 2nd Edition, Pearson publication, 2007.

### REFERENCE BOOKS:

1. Microprocessors and Interfacing: Programming and Hardware, Douglas V. Hall
2. Microcomputer Experimentation with the Intel SDK-85, Lance A. Leventhal, Prentice Hall
3. Introduction to Microprocessors, Aditya P Mathur, Tata McGraw-Hill, Europe; 3<sup>rd</sup> Edition, 1990.
4. Digital Electronics: An Introduction to Theory and Practice, William H. Gothmann, PHI Learning Private Limited.
5. Digital and microprocessor technology, Patrick J O'Connor, Prentice-Hall, 1983.
6. Digital and Microprocessor Engineering, S.J.Cahill, Willis Horwood Limited (John Wiley &

Sons).

7. Digital Control Systems, Benjamin C. Kuo, Oxford University Press (2/e, Indian Edition, 2007).
8. Digital Computer Electronics: An Introduction to Microcomputers, Albert Pual Malvino, Tata McGraw-Hill Publishing Company Ltd.



## 22ME611-OE: BASIC MECHANICAL ENGINEERING (OPEN ELECTIVE – I)

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

**Course objectives:** To provide the essential basic knowledge of Mechanical Engineering to the students

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

- Understand different types of power generation, working of refrigerator
- Summarize different types of manufacturing processes and Power transmission systems
- Discuss about conventional and non-conventional sources of energy
- Identify automation of various manufacturing processes in engineering practice.
- Describe the basic concepts and applications of industrial robotics

### UNIT- I:

Energy: Power Generation: External and internal combustion engines-Thermal Power Plants-Working Principle, layouts, element/component description, advantages, disadvantages, applications.

2-Stroke, 4-Stroke Engines and their Components.

Refrigeration: Mechanical Refrigeration and types – units of refrigeration – Air Refrigeration system, Vapour Compression Refrigeration System- Principle of operation.

### UNIT- II:

Machine and Mechanisms-Degrees of Freedom, functions of Flywheel and Governors, Types of joints-Riveted, welded and bolted joints. Applications, Merits and Demerits.

Power Transmission Elements: Gears terminology of spur, helical and bevel gears, gear trains. Beltdrives (types). Chain drives.

### UNIT- III:

Manufacturing Processes: Primary and secondary process. Casting: Types, equipment, applications. Metal forming processes-rolling, extrusion

Welding: Types – Equipment – Techniques employed – advantages / disadvantages – Gas cutting – Brazing and soldering.

### UNIT- IV:

Machine Tools: Introduction to lathe, drilling machine, milling machine, grinding machine- Operations performed. CNC Machines- Basic elements, advantages. Limits, fits and tolerances, Surface finish of various manufacturing process.

**UNIT- V:** Non-conventional sources of energy-Solar, wind, tidal, biogas and nuclear- Principles. Robotics – Joints, end effectors, applications. Introduction to 3D Printing.

### TEXT BOOKS:

1. Sadhu Singh, Basic Mechanical Engineering, S. Chand & Co. Ltd, New Delhi, 2013
2. Pravin Kumar, Basic mechanical Engineering, 2018, Pearson

**REFERENCE BOOKS:**

1. Hajra Choudhary, S.K. and Hajra Choudhary, A. K., Elements of Workshop Technology Vols.I& II, Indian Book Distributing Company Calcutta, 2007.
2. Nag, P.K., Power Plant Engineering, Tata McGraw-Hill, New Delhi, 2008.
3. Rattan, S.S., Theory of Machines, Tata McGraw-Hill, New Delhi, 2010.

## 22ME612-OE: RENEWABLE ENERGY SOURCES (OPEN ELECTIVE – I)

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	3

### Course Objectives:

- To provide an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application.
- To explore society's present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy.
- To focus on alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro, Energy conservation methods.

### Course Outcomes:

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

- Explain the main sources of energy including Solar energy and their primary applications in Global Context.
- Describe the challenges and problems associated with the use of solar energy sources and its Economic Evaluation
- Discuss significance of Wind energy systems and its components with basic working principles
- Elaborate the sources of energy from water by various means such as OTEC, Tidal energy etc.
- Narrate the importance and potential of geo thermal energy and MHD power generation

### UNIT- I:

**Solar Radiation And Collecting Devices:** Solar Incident Flux, Extra-terrestrial Radiation, Clear Sky Irradiation, Solar Radiation Measurement, Monthly Average Radiation on Tilted Surfaces. Cover plates, Collector Plate Surfaces, Collector Performance, Collector Improvement, Effect of Incident Angle, Heat Transfer to Fluids, Heat Transfer Factors, Concentrating Collectors, Reflectors.

### UNIT- II:

**Solar System Design And Economic Evaluation** Hot water heating, heating and hot water systems , pumps and fans, sizing pipe and duct work, fundamentals of economic analysis, systems optimization

### UNIT- III:

**Wind Energy Systems:** Orientation systems and Regulating devices, Types of Wind Turbines, Operating Characteristics, Basics of Airfoil Theory, Wind energy for water pumping and generation of electricity, Installation operation and maintenance of small wind energy conversion systems.

### UNIT-IV:

**Energy From Water:** OTEC–Principle of operation, Open and Closed OTEC cycles, Wave energy: Wave energy conversion machines and recent advances Tidal Energy: Single basin and double basintidal systems Small-Mini-Micro hydro system: Concepts, Types of turbines, Hydrological analysis.

**UNIT- V:**

**Geothermal Energy:** Introduction, Classification of Geo-thermal areas, Applications of Geo-thermal energy for power generation, Economics of Geo-thermal energy. MHD POWER GENERATION: Principles of MHD Power Generation, Ideal MHD–Generator Performance, Practical MHD Generator: Faraday and Hall Configurations, MHD Technology.

**TEXT BOOKS:**

1. Non-Conventional sources of Energy by G. D. Rai, Kanna Publications.
2. Non-conventional Energy resources, BH Khan, McGraw-Hill

**REFERENCE BOOKS:**

1. Fundamentals of Renewable Energy Sources, G. N. Tiwari, Ghosal, Alpha Science
2. Solar Energy Fundamentals and Applications, H. P Garg, Prakash, TMH.
3. Solar Energy: Principles of thermal storage, S. P Sukhatme, TMH

## 22ME604-PC: HEAT TRANSFER LAB

B.Tech. III Year, II Sem.

L	T	P	C
0	0	2	1

**Pre-requisite:** Thermodynamics

**Course Objectives:** To enable the student to apply conduction, convection and radiation heattransfer concepts to practical applications

**Course Outcome:** At the end of the lab sessions, the student will be able to

- Perform steady state conduction experiments to estimate thermal conductivity of different materials
- Perform transient heat conduction experiment
- Estimate heat transfer coefficients in forced convection, free convection, condensation and correlate with theoretical values
- Obtain variation of temperature along the length of the pin fin under forced and free convection
- Perform radiation experiments: Determine surface emissivity of a test plate and Stefan-Boltzmann's constant and compare with theoretical value

**Minimum ten experiments from the following:**

1. Composite Slab Apparatus – Overall heat transfer co-efficient.
2. Heat transfer through lagged pipe.
3. Heat Transfer through a Concentric Sphere
4. Thermal Conductivity of given metal rod.
5. Heat transfer in pin-fin
6. Experiment on Transient Heat Conduction
7. Heat transfer in forced convection apparatus.
8. Heat transfer in natural convection
9. Parallel and counter flow heat exchanger.
10. Emissivity apparatus.
11. Stefan Boltzman Apparatus.
12. Critical Heat flux apparatus.
13. Study of heat pipe and its demonstration.
14. Film and Drop wise condensation apparatus

## 22ME605-PC: COMPUTER AIDED ENGINEERING LAB

B.Tech. III Year, II Sem.

L	T	P	C
0	0	2	1

### Course Objectives:

- To be able to understand and handle design problems in a systematic manner.
- To be able to apply CAD in real life applications.
- To understand the basic principles of different types of analysis.

### Course Outcomes:

- To understand the analysis of various aspects in design
- To have exposure to usage of software tools for design and manufacturing.
- To acquire the skills needed to analyze and simulate engineering systems.

### Note: conduct any TEN exercises from the list given below:

1. Drafting: Development of part drawings for various components in the form of orthographic and isometric. Representation of dimensioning and tolerances.
2. Part Modeling: Generation of various 3D Models through Protrusion, revolve, sweep. Creation of various features. Study of parent child relation. Feature based and Boolean based modeling and Assembly Modeling. Study of various standard Translators. Design of simple components.
3. Determination of deflection and stresses in 2D and 3D trusses and beams.
4. Determination of deflections, principal and Von-mises stresses in plane stress, plane strain and Axi-symmetric components.
5. Determination of stresses in 3D and shell structures (at least one example in each case)
6. Estimation of natural frequencies and mode shapes, Harmonic response of 2D beam.
7. Study state heat transfer analysis of plane and axi-symmetric components.
8. Development of process sheets for various components based on Tooling and Machines.
9. Development of manufacturing defects and tool management systems.
10. Study of various post processors used in NC Machines.
11. Development of NC code for free form and sculptured surfaces using CAM software.
12. Machining of simple components on NC lathe and Mill by transferring NC Code / from CAM software.

## 22EN601-HS: ADVANCED ENGLISH COMMUNICATION SKILLS LAB

B.Tech. III Year, II Sem.

L	T	P	C
0	0	2	1

### 1. Introduction

The introduction of the Advanced English Communication Skills Lab is considered essential at the B.Tech 3<sup>rd</sup> year level. At this stage, the students need to prepare themselves for their career which may require them to listen to, read, speak and write in English both for their professional and interpersonal communication in the globalised context.

The proposed course should be a laboratory course to enable students to use appropriate English and perform the following:

1. Gathering ideas and information to organise ideas relevantly and coherently.
2. Making oral presentations.
3. Writing formal letters.
4. Transferring information from non-verbal to verbal texts and vice-versa.
5. Writing project/research reports/technical reports.
6. Participating in group discussions.
7. Engaging in debates.
8. Facing interviews.
9. Taking part in social and professional communication.

### 2. Objectives:

This Lab focuses on using multi-media instruction for language development to meet the following targets:

- To improve the students' fluency in English, with a focus on vocabulary
- To enable them to listen to English spoken at normal conversational speed by educated English speakers
- To respond appropriately in different socio-cultural and professional contexts
- To communicate their ideas relevantly and coherently in writing
- To prepare the students for placements.

### 3. Syllabus:

The following course content to conduct the activities is prescribed for the Advanced English Communication Skills (AECS) Lab:

1. **Activities on Listening and Reading Comprehension:** Active Listening — Development of Listening Skills Through Audio clips - Benefits of Reading – Methods and Techniques of Reading  
– Basic Steps to Effective Reading – Common Obstacles – Discourse Markers or Linkers - Sub-skills of reading - Reading for facts, negative facts and Specific Details- Guessing Meanings from Context, Inferring Meaning - Critical Reading — Reading Comprehension – Exercises for Practice.
2. **Activities on Writing Skills:** Vocabulary for Competitive Examinations - Planning for Writing – Improving Writing Skills - Structure and presentation of different types of writing – Free Writing and Structured Writing - Letter Writing – Writing a Letter of Application – Resume vs. Curriculum Vitae  
– Writing a Résumé – Styles of Résumé - e-Correspondence – Emails – Blog Writing - (N)etiquette  
– Report Writing – Importance of Reports – Types and Formats of Reports – Technical Report Writing – Exercises for Practice.
3. **Activities on Presentation Skills** - Starting a conversation – responding appropriately and relevantly – using the right language and body language – Role Play in different situations including Seeking Clarification, Making a Request, Asking for and Refusing Permission,

Participating in a Small Talk – Oral presentations (individual and group) through JAM sessions- PPTs – Importance of Presentation Skills – Planning, Preparing, Rehearsing and Making a Presentation – Dealing with Glossophobia or Stage Fear – Understanding Nuances of Delivery - Presentations through Posters/Projects/Reports – Checklist for Making a Presentation and Rubrics of Evaluation

4. **Activities on Group Discussion (GD):** Types of GD and GD as a part of a Selection Procedure - Dynamics of Group Discussion- Myths of GD - Intervention, Summarizing - Modulation of Voice, Body Language, Relevance, Fluency and Organization of Ideas – Do's and Don'ts - GD Strategies – Exercises for Practice.
5. **Interview Skills:** Concept and Process - Interview Preparation Techniques - Types of Interview Questions – Pre-interview Planning, Opening Strategies, Answering Strategies - Interview Through Tele-conference & Video-conference - Mock Interviews.

#### 4. **Minimum Requirement:**

The Advanced English Communication Skills (AECS) Laboratory shall have the following infrastructural facilities to accommodate at least 35 students in the lab:

- Spacious room with appropriate acoustics
- Round Tables with movable chairs
- Audio-visual aids
- LCD Projector
- Public Address system
- One PC with latest configuration for the teacher
- T. V, a digital stereo & Camcorder
- Headphones of High quality

**5. Suggested Software:** The software consisting of the prescribed topics elaborated above should be procured and used.

- **TOEFL & GRE** (KAPLAN, AARCO & BARRONS, USA, Cracking GRE by CLIFFS)
- **Oxford Advanced Learner's Dictionary**, 10<sup>th</sup> Edition
- **Cambridge Advanced Learner's Dictionary**
- **DELTA's key to the Next Generation TOEFL Test: Advanced Skill Practice.**
- **Lingua TOEFL CBT Insider**, by Dreamtech

#### 6. **Books Recommended:**

1. Rizvi, M. Ashraf (2018). *Effective Technical Communication*. (2<sup>nd</sup> ed.). McGraw Hill Education (India) Pvt. Ltd.
2. Suresh Kumar, E. (2015). *Engineering English*. Orient BlackSwan Pvt. Ltd.
3. Bailey, Stephen. (2018). *Academic Writing: A Handbook for International Students*. (5<sup>th</sup> Edition). Routledge.
4. Koneru, Aruna. (2016). *Professional Communication*. McGraw Hill Education (India) Pvt. Ltd.
5. Raman, Meenakshi & Sharma, Sangeeta. (2022). *Technical Communication, Principles and Practice*. (4<sup>th</sup> Edition) Oxford University Press.
6. Anderson, Paul V. (2007). *Technical Communication*. Cengage Learning Pvt. Ltd. New Delhi.
7. McCarthy, Michael; O'Dell, Felicity & Redman, Stuart. (2017). *English Vocabulary in Use Series*. Cambridge University Press
8. Sen, Leela. (2009). *Communication Skills*. PHI Learning Pvt Ltd., New Delhi.
9. Elbow, Peter. (1998). *Writing with Power*. Oxford University Press.
10. Goleman, Daniel. (2013). *Emotional Intelligence: Why it can matter more than IQ*. Bloomsbury Publishing.



## \*22MC609: ENVIRONMENTAL SCIENCE

B.Tech. III Year, II Sem.

L	T	P	C
3	0	0	0

### Course Objectives:

- Understanding the importance of ecological balance for sustainable development.
- Understanding the impacts of developmental activities and mitigation measures
- Understanding the environmental policies and regulations

### Course Outcomes:

Based on this course, the Engineering graduate will understand /evaluate / develop technologies on the basis of ecological principles and environmental regulations which in turn helps in sustainable development

### UNIT – I:

**Ecosystems:** Definition, Scope and Importance of ecosystem. Classification, structure, and function of an ecosystem, Food chains, food webs, and ecological pyramids. Flow of energy, Biogeochemical cycles, Bioaccumulation, Biomagnification, ecosystem value, services and carrying capacity, Field visits.

### UNIT – II:

**Natural Resources: Classification of Resources:** Living and Non-Living resources, **water resources:** use and over utilization of surface and ground water, floods and droughts, Dams: benefits and problems. **Mineral resources:** use and exploitation, environmental effects of extracting and using mineral resources, **Land resources:** Forest resources, **Energy resources:** growing energy needs, renewable and non-renewable energy sources, use of alternate energy source, case studies.

### UNIT – III:

**Biodiversity and Biotic Resources:** Introduction, Definition, genetic, species and ecosystem diversity. Value of biodiversity; consumptive use, productive use, social, ethical, aesthetic and optional values. India as a mega diversity nation, Hot spots of biodiversity. Field visit. Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts; conservation of biodiversity: In-Situ and Ex-situ conservation. National Biodiversity act.

### UNIT – IV:

**Environmental Pollution and Control Technologies: Environmental Pollution:** Classification of pollution, **Air Pollution:** Primary and secondary pollutants, Automobile and Industrial pollution, Ambient air quality standards. **Water pollution:** Sources and types of pollution, drinking water quality standards. **Soil Pollution:** Sources and types, Impacts of modern agriculture, degradation of soil. **Noise Pollution:** Sources and Health hazards, standards, **Solid waste:** Municipal Solid Waste management, composition and characteristics of e-Waste and its management. **Pollution control technologies:** Wastewater Treatment methods: Primary, secondary and Tertiary.

Overview of air pollution control technologies, Concepts of bioremediation. **Global Environmental Problems and Global Efforts:** Climate change and impacts on human environment. Ozone depletion and Ozone depleting substances (ODS). Deforestation and desertification. International conventions / Protocols: Earth summit, Kyoto protocol, and Montréal Protocol.

## **UNIT – V:**

**Environmental Policy, Legislation & EIA:** Environmental Protection act, Legal aspects Air Act- 1981, Water Act, Forest Act, Wild life Act, Municipal solid waste management and handling rules, biomedical waste management and handling rules, hazardous waste management and handling rules. EIA: EIA structure, methods of baseline data acquisition. Overview on Impacts of air, water, biological and Socio-economical aspects. Strategies for risk assessment, Concepts of Environmental Management Plan (EMP). **Towards Sustainable Future:** Concept of Sustainable Development, Population and its explosion, Crazy Consumerism, Environmental Education, Urban Sprawl, Human health, Environmental Ethics, Concept of Green Building, Ecological Foot Print, Life Cycle assessment (LCA), Low carbon life style.

### **TEXT BOOKS:**

1. Textbook of Environmental Studies for Undergraduate Courses by Erach Bharucha for University Grants Commission.
2. Environmental Studies by R. Rajagopalan, Oxford University Press.

### **REFERENCE BOOKS:**

1. Environmental Science: towards a sustainable future by Richard T. Wright. 2008 PHL Learning Private Ltd. New Delhi.
2. Environmental Engineering and science by Gilbert M. Masters and Wendell P. Ela. 2008 PHI Learning Pvt. Ltd.
3. Environmental Science by Daniel B. Botkin & Edward A. Keller, Wiley INDIA edition.
4. Environmental Studies by Anubha Kaushik, 4<sup>th</sup> Edition, New age international publishers.
5. Text book of Environmental Science and Technology - Dr. M. Anji Reddy 2007, BS Publications.

## 22ME701-PC: INDUSTRIAL MANAGEMENT

B.Tech. IV Year, I Sem.

L	T	P	C
2	0	0	2

**Prerequisites:** None

**Course objectives:**

- Understand the philosophies of management gurus
- Understand the various types of organization structures and their features, and Their advantages and disadvantages.
- Learning various Industrial Engineering Practices like Operations Management techniques, work study, statistical quality control techniques, Job evaluation techniques and network analysis techniques.

**Course outcomes: At the end of the course, the student would be able to**

- apply principles of management
- design the organization structure
- apply techniques for plant location, design plant layout and value analysis
- carry out work study to find the best method for doing the work and establish standard time for a given method
- apply various quality control techniques and sampling plans
- do job evaluation and network analysis.

**UNIT – I:**

**Introduction to Management:** Entrepreneurship and organization — Nature and Importance of Management, Functions of Management, Taylor’s Scientific Management Theory, Fayol’s Principles of Management, Maslow’s Theory of Human Needs, Douglas McGregor’s Theory X and Theory Y, Herzberg’s Two-Factor Theory of Motivation, Systems Approach to Management, Leadership Styles, Social responsibilities of Management

**UNIT – II:**

**Designing Organizational Structures:** Departmentalization and Decentralization, Types of Organization structures — Line organization, Line and staff organization, functional organization, Committee organization, matrix organization, Virtual Organization, Cellular Organization, team structure, boundary less organization, inverted pyramid structure, lean and flat organization structure and their merits, demerits and suitability.

**UNIT – III:**

**Operations Management:** Objectives- product design process- Process selection-Types of production system (Job, batch and Mass Production), Plant location-factors- Urban-Rural sites comparison- Types of Plant Layouts- Design of product layout- Line balancing (RPW method) Value analysis-Definition- types of values- Objectives- Phases of value analysis- Fast diagram

**UNIT - IV:**

**Work Study:** Introduction — definition — objectives — steps in work study — Method study — definition, objectives — steps of method study. Work Measurement — purpose — types of study — stop watch methods — steps — key rating — allowances — standard time calculations — worksampling.

**Statistical Quality Control:** variables-attributes, Shewart control charts for variables-chart, R chart, –Attributes- Defective-Defect- Charts for attributes-p-chart -c chart (simple

Problems), Acceptance Sampling- Single sampling- Double sampling plans-OC curves.

**UNIT – V:**

**Job Evaluation:** Methods of job evaluation — simple routing objective systems — classification method factor comparison method, point method, benefits of job evaluation and limitations. **Project Management (PERT/CPM):** Network Analysis, Programme Evaluation and Review Technique (PERT), Critical Path Method (CPM), Identifying critical path, Probability of Completing the project within given time, Project Cost Analysis, Project Crashing. (simple problems)

**TEXT BOOKS:**

1. Industrial Engineering and Management/O.P. Khanna/Khanna Publishers.
2. Industrial Engineering and Management Science/T.R. Banga and S.C. Sarma/Khanna Publishers.

**REFERENCE BOOKS:**

1. Motion and Time Study by Ralph M Barnes! John Willey & Sons Work Study by ILO.
2. Human factors in Engineering & Design/Ernest J McCormick /TMH.
3. Production & Operation Management /Paneer Selvam/PHI.
4. Industrial Engineering Management/NVS Raju/Cengage Learning.
5. Industrial Engineering Hand Book/Maynard.
6. Industrial Engineering Management I Ravi Shankar/Galgotia.

## 22ME702-PC: REFRIGERATION & AIR CONDITIONING

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Prerequisites:** Thermodynamics

### Course Objectives:

- Apply the principles of thermodynamics to analyze different types of refrigeration and HAV
- To understand the functionality of the major components of the refrigeration and HAV
- To apply the knowledge in effective refrigeration and HAV systems for better performances in real context
- Discuss the heating procedure by Air conditioning process
- Explain the requirement of ventilation devices/processes

### Course Outcomes:

- Differentiate between different types of refrigeration systems with respect to application as well as conventional & unconventional refrigeration systems.
- Analyse thermodynamically low temperature refrigeration and Vapour absorption refrigeration for evaluation of performance parameters.
- Apply the air refrigeration principles for different types of Air craft refrigeration systems
- Elaborate the principles of psychometrics to design the air conditioning heating /cooling loads for industrial applications.
- explain the requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load

### UNIT– I:

**Vapour Compression Refrigeration:** Performance of Complete vapor compression system. Actual Vs Ideal cycle - Effect of operating parameters on COP, **Components of Vapor Compression System:** The condensing unit – Evaporators – Expansion valve – Refrigerants – Properties – ODP & GWP - Load balancing of vapor compression Unit.

**Compound Compression:** Flash inter-cooling – flash chamber – Multi-evaporator & Multistage systems.

### UNIT– II:

**Production of Low Temperature:** Liquefaction system, Liquefaction of gases, Hydrogen and Helium, Cascade System – Applications– Dry ice system.

**Vapor absorption system** – Simple and modified aqua – ammonia system – Representation on Enthalpy – Concentration diagram.  
Lithium – Bromide system Three fluid system – HCOP.

### UNIT– III:

**Air Refrigeration:** Applications – Air Craft Refrigeration -Simple, Bootstrap, Regenerative and Reduced ambient systems – Problems based on different systems.

**Steam Jet refrigeration system:** Representation on T-s and h-s diagrams – limitations and applications.

**Unconventional Refrigeration system** – Thermo-electric – Vortex tube & Pulse tube – working principles.

### UNIT– IV:

**Air Conditioning:** Psychometric properties and processes – Construction of Psychometric

chart. Requirements of Comfort Air –conditioning – Thermodynamics of human body – Effective temperature and Comfort chart – Parameters influencing the Effective Temperature.

**Heating Load Calculations:** Summer/ Winter heating load calculation-heat losses through structure-heat losses due to infiltration. Effects of solar radiation and internal heat sources on heating loads. Air Heating System: Classification - gravity warm heating system, forced warm air heating system balancing a warm air heating system, warm air furnaces, air cleaners, humidifiers & De-humidifiers

#### **UNIT– V:**

**Air Conditioning Systems:** All Fresh air, Re-circulated air with and without bypass, with reheat systems – Calculation of Bypass Factor, ADP, RSHF, ESHF and GSHF for different systems.

**Ventilation:** Ventilation and Infiltration: Requirement of ventilation air, various sources of infiltration air, ventilation and infiltration as a part of cooling load. Fans and Blowers: Types, performance characteristics, series and parallel arrangement, selection procedure. Equipments and Controls: Chillers, Condensing units, Cooling coils, bypass factors, humidifiers, dehumidifiers

#### **TEXT BOOKS:**

1. Refrigeration & Air Conditioning by C.P. Arora, TMH.
2. Refrigeration & Air Conditioning by Arora & Domkundwar, Dhanpat Rai.
3. Refrigeration and Air Conditioning by Manohar Prasad

#### **REFERENCE BOOKS:**

1. Basic Refrigeration & Air Conditioning by P.N. Ananthanarayanan, McGraw Hill.
2. Refrigeration and Air Conditioning by Stoecker, Mc Graw Hill.
3. Refrigeration and Air Conditioning by Dr. S.S. Thipse, Jaico.
4. Refrigeration and Air Conditioning by Jordan & Preister, Prentice Hall.
5. Refrigeration and Air Conditioning by Dossat, Mc Graw Hill.

## 22ME72A-PE: ADDITIVE MANUFACTURING (PROFESSIONAL ELECTIVE – II)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Pre-requisites:** Manufacturing Processes, Engineering Materials

### Course Objectives:

- To understand the fundamental concepts of Additive Manufacturing (i.e. Rapid Prototyping) and 3-D printing, its advantages and limitations.
- To classify various types of Additive Manufacturing Processes and know their working principle, advantages, limitations etc.
- To have a holistic view of various applications of these technologies in relevant fields such as mechanical, Bio-medical, Aerospace, electronics etc.

**Course Outcomes:** After the completion of the course, the student will be able to

- Explain and summarize the principles and key characteristics of additive manufacturing technologies and commonly used 3D printing and additive manufacturing systems.
- Describe various liquid based Rapid Prototyping systems.
- Understand and apply different powder based Rapid Prototype systems.
- Describe various CAD issues for 3D printing and rapid prototyping and related operations for STL model manipulation.
- Understand and apply Rapid prototyping in various applications like forensic science, anthropology and medicine etc.

### UNIT – I:

**Introduction:** Prototyping fundamentals, Historical development, Fundamentals of Rapid Prototyping, Advantages and Limitations of Rapid Prototyping, Commonly used Terms, Classification of RP process, Rapid Prototyping Process Chain: Fundamental Automated Processes.

### UNIT – II:

**Liquid-based Rapid Prototyping Systems:** Stereo lithography Apparatus (SLA): Models and specifications, Process, working principle, photopolymers, photo polymerization, Layering technology, laser and laser scanning, Applications, Advantages and Disadvantages, Case studies. Solid ground curing (SGC): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Solid-based Rapid Prototyping Systems: Laminated Object Manufacturing (LOM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Fused Deposition Modeling (FDM): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies.

### UNIT – III:

**Powder Based Rapid Prototyping Systems:** Selective laser sintering (SLS): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Three dimensional Printing (3DP): Models and specifications, Process, working principle, Applications, Advantages and Disadvantages, Case studies. Rapid Tooling: Introduction to Rapid Tooling (RT), Conventional Tooling Vs RT, Need for RT. Rapid Tooling Classification; Indirect Rapid Tooling Methods: Spray Metal Deposition, RTV Epoxy Tools, Ceramic tools, Investment Casting, Spin Casting, Die casting, Sand Casting, 3D

Keltool process. Direct Rapid Tooling: Direct AIM, LOM Tools, DTM Rapid Tool Process, EOS Direct Tool Process and Direct Metal Tooling using 3DP

**UNIT – IV:**

Rapid Prototyping Data Formats: STL Format, STL File Problems, Consequence of Building Valid and Invalid Tessellated Models, STL file Repairs: Generic Solution, Other Translators, Newly Proposed Formats. Rapid Prototyping Software's: Features of various RP software's like Magics, Mimics, Solid View, View Expert, 3 D View, Velocity 2, Rhino, STL View 3 Data Expert and 3 D doctor.

**UNIT – V:**

RP Applications: Application - Material Relationship, Application in Design, Application in Engineering, Analysis and Planning, Aerospace Industry, Automotive Industry, Jewelry Industry, Coin Industry, GIS application, Arts and Architecture. RP Medical and Bioengineering Applications: Planning and simulation of complex surgery, Customized Implants & Prosthesis, Design and Production of Medical Devices, Forensic Science and Anthropology, Visualization of Biomolecules.

**TEXT BOOKS:**

1. Rapid prototyping; Principles and Applications /Chua C.K., Leong K.F. and LIM C.S/World Scientific Publications/3<sup>rd</sup> Edition, 2010
2. Rapid Manufacturing /D.T. Pham and S.S. Dimov/Springer/1<sup>st</sup> Edition, 2012

**REFERENCE BOOKS:**

1. Terry Wohlers, Wholers Report 2000, Wohlers Associates.
2. Rapid Prototyping and Manufacturing /PaulF. Jacobs/ASME/ 1<sup>st</sup> Edition, 1993.



## 22ME72B-PE: AUTOMATION IN MANUFACTURING (PROFESSIONAL ELECTIVE – II)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

### Course Objectives:

- To understand types of Automation and production system technologies in modern manufacturing.
- To understand importance of automated flow lines in manufacturing a product.
- To understand the Assembly system and Line Balancing in Manufacturing System.
- To understand Automated Material handling equipments and Automated Storage Systems.
- To understand industrial control and automatic inspection techniques.

**Course Outcomes:** After the completion of the course, the student will be able to

- Describe the importance of Automation implementation in Manufacturing.
- Analyze the various Automated flow lines.
- Perform Line balancing of assembly system.
- Describe automated Material Handling and automated storage
- Explain Industrial Process controls and automatic inspection.

### UNIT – I:

**Introduction:** Types and strategies of automation, pneumatic and hydraulic components circuits, Automation in machine tools. Mechanical feeding and tool changing and machine tool control transfer the automaton.

### UNIT – II:

**Automated flow lines:** Methods or work part transport transfer Mechanical buffer storage control function, design and fabrication consideration.

**Analysis of Automated flow lines:** General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.

### UNIT – III:

**Assembly system and line balancing:** Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines.

### UNIT –IV:

**Automated material handling:** Types of equipment, functions, analysis and design of material handling systems conveyor systems, automated guided vehicle systems.

Automated storage systems, Automated storage and retrieval systems; work in process storage, interfacing handling and storage with manufacturing.

### UNIT –V:

**Fundamentals of Industrial controls:** Review of control theory, logic controls, sensors and actuators, Data communication and LAN in Manufacturing.

Business process Re-engineering: Introduction to BPE logistics, ERP, Software configuration of BPE.

### TEXT BOOKS:

1. Automation, Production Systems and Computer Integrated Manufacturing: M.P. Groover. /Pearson Education/4<sup>th</sup> Edition, 2016.
2. Computer Control of Manufacturing Systems/ Yoram koren/ Mc Graw Hill/ 1<sup>st</sup> Edition, 1983.

### REFERENCE BOOKS:

1. Computer Aided Manufacturing/Tien-Chien Chang, Richard A. Wyskand Hsu-Pin Wang/Pearson/ 3<sup>rd</sup> Edition, 2005.

**22ME72C-PE: ARTIFICIAL INTELLIGENCE IN MECHANICAL ENGINEERING  
(PROFESSIONAL ELECTIVE – II)**

**B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**UNIT - I: Introduction to Artificial Intelligence**

Definition, History, Present state of Artificial Intelligence (AI), Phases of AI, Approaches to AI - Hard or Strong AI, Soft or Weak AI, Applied AI, Cognitive AI, and Applications domains focused on mechanical engineering,

**UNIT - II: Problem Solving Methods**

Problem solving methods-1. Uninformed search includes Depth First Search (DFS), Breadth First Search (BFS), Uniform Cost Search (UCS), Depth Limited Search, Iterative Deepening Depth First Search (IDDFS) and bidirectional search. 2. Informed Search (heuristic search) includes greedy best first search, A\* search, memory bounded heuristic search, learning to search better, Simple problems

**UNIT - III: Neural Networks**

Introduction to Perceptron and Neural Networks, Activation and Loss functions, Single Neuron of Human and Human Brain Modelling, ANN architecture-Input layer, Hidden layer and output layer, Types of Neural Networks- Single layer feed-forward network, Multilayer feed-forward network, Multi-Layer Perceptron (MLP), Recurrent networks or feedback ANN, Characteristics of Neural Networks, Simple problems on Back Propagation Algorithms to minimize the error

**UNIT - IV: Machine Learning**

Unsupervised learning- Definition, basic concepts, applications, K-means Clustering, hierarchical Clustering, Dimension Reduction-PCA, Simple Examples

Supervised Learning - Definition, basic concepts, applications, Linear Regression, Multiple Variable Linear Regression, Logistic Regression, Naive Bayes Classifiers, k-NN Classification, Support Vector Machine, Simple Examples.

Reinforcement Learning (RL) - Framework, Component of RL Framework, Types of RL Systems. Q- learning, Examples of RL Systems, Simple Examples

**UNIT - V: Ensemble Learning Techniques**

Introduction on ensemble methods, Decision Trees, Bagging, Random Forests, Boosting, Simple Examples

**TEXT BOOK:**

1. Artificial Intelligence: A Modern Approach, Stuart Russell & Peter Norvig, Prentice-Hall, Third Edition (2009).

**REFERENCE BOOKS:**

1. Artificial Intelligence, Ela Kumar, Wiley, 2021
2. Artificial Intelligence: Concepts and Applications, Lavika Goel, Kindle Edition, Wiley, 2021.
3. Nature-Inspired Optimization in Advanced Manufacturing Processes and Systems, Edited by Ganesh M. Kakandikar and Dinesh G. Thakur, CRC press, First edition, 2021.

## 22ME72D-PE: MECHATRONICS (PROFESSIONAL ELECTIVE – II)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

### UNIT - I:

**Introduction:** Overview, History of mechatronics, Scope and significance of Mechatronics systems, elements of Mechatronic systems, Needs and benefits of Mechatronics in manufacturing.

**Sensors:** Classification of sensors basic working principles, displacement sensor – linear and rotary potentiometers, LVDT and RVDT, incremental and absolute encoders, Proximity and range sensors – Eddy current sensor, ultrasonic sensor, laser interferometer transducer, hall Effect sensor, inductive Proximity switch, Light sensors – Photodiodes, Phototransistors, Flow Sensors – ultrasonic Sensor, Laser Doppler Anemometer, Tactile Sensors – PVDF tactile sensor, micro-switch and reed switch, Piezoelectric sensors, Vision Sensor.

### UNIT - II:

**Actuators: Electrical Actuators:** Solenoids, relays, diodes, thyristors, triacs, BJT, FET, DC motor, Servo Motor, BLDC Motor, AC Motor, Stepper Motor, Hydraulic & pneumatic devices – Power supplies, valves, Cylinder sequencing, Design of hydraulic & pneumatic circuits. Piezo Electric Actuators, Shapememory alloys.

### UNIT - III:

**Basic System models & Analysis:** Modeling of one & two degrees of freedom Mechanical, Electrical, fluid and thermal systems, block diagram representations of these systems. Dynamic Responses of System: Transfer function, modeling dynamic systems, first order systems, second order systems.

### UNIT - IV:

**Digital Electronics:** Number systems, BCD codes and arithmetic, Gray codes, self-complementing codes, Error detection and correction principles. Boolean functions using Karnaugh Map, Design of combinational circuits, design of arithmetic circuits, Design of code converters, encoders and decoders. **Signal Conditioning:** Operational amplifiers, inverting amplifier, differential amplifier, Protection, comparator, filters, multiplexer, Pulse width modulation counters, decoders. Data acquisition — Quantizing theory, Analog to digital conversion, digital to analog conversion.

**Controllers:** Classification of Control systems, Feedback, Closed loop and open loop systems **PLC**

### UNIT - V:

**Programming:** PLC Principles of operation, PLC sizes, PLC hardware components, I/O section Analog I/O section, Analog I/O modules, digital I/O modules, CPU processor memory, module programming, Ladder Programming, ladder diagrams, Timers, Internal relays and counters, data handling, analogue input and output. Application on real time industrial automation systems.

**Advanced Applications in Mechatronics:** Sensors for condition monitoring, mechatronic control in automated manufacturing, Artificial intelligence in Mechatronics, micro sensors in mechatronics, Application of Washing machine as mechatronic device.

**TEXT BOOKS:**

1. W. Boton, "Mechatronics", 5th edition, Adison Wesley Longman Ltd, 2010.
2. Mechatronics system design by Devdas Shetty and Richard A. Kolk, P.W.S. Publishing company, 2001.
3. Alciatore David G & Histan Michael B, "Introduction to Mechatronics and Measurement systems", 4th edition, Tata McGraw Hill, 2006

## 22ME73A-PE: POWER PLANT ENGINEERING (PROFESSIONAL ELECTIVE – III)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Pre-Requisites:** None

**Course Objectives:** The goal of this course is to be aware of the design of conventional and alternative power-generation plants. The learning objectives include

- Analysis and preliminary design of the major systems of conventional fossil-fuel steam-cycle power plants.
- A working knowledge of the basic design principles of nuclear, gas turbine, combined cycle, hydro, wind, geothermal, solar, and alternate power plants.
- Awareness of the economic, environmental, and regulatory issues related to power generation.

**Course Outcomes:** At the end of the course students will be able to:

- Understand the concept of Rankine cycle.
- Understand working of boilers including water tube, fire tube and high-pressure boilers and determine efficiencies.
- Analyze the flow of steam through nozzles.
- Evaluate the performance of condensers and steam turbines.
- Evaluate the performance of gas turbines.

### UNIT – I:

Introduction to the Sources of Energy – Resources and Development of Power in India.

**Steam Power Plant:** Plant Layout, Working of different Circuits, Fuel and handling equipments, types of coals, coal handling, choice of handling equipment, coal storage, Ash handling systems.

**Combustion Process:** Properties of coal – overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, retort stokers, pulverized fuel burning system and its components, combustion needs and draught system, cyclone furnace, design and construction, Dust collectors, cooling towers and heat rejection. Corrosion and feed water treatment.

### UNIT – II:

**Internal Combustion Engine Plant:** Diesel Power Plant: Introduction – IC Engines, types, construction – Plant layout with auxiliaries – fuel supply system, air starting equipment, lubrication and cooling system – super charging.

**Gas Turbine Plant:** Introduction – classification - construction – Layout with auxiliaries – Principles of working of closed and open cycle gas turbines. Combined Cycle Power Plants and comparison.

### UNIT – III:

**Hydro Electric Power Plant:** Water power – Hydrological cycle / flow measurement – drainage area characteristics – Hydrographs – storage and Pondage – classification of dams and spill ways.

**Hydro Projects and Plant:** Classification – Typical layouts – plant auxiliaries – plant operation pumped storage plants.

### UNIT – IV:

**Nuclear Power Station:** Nuclear fuel – breeding and fertile materials – Nuclear reactor – reactor operation. **Types of Reactors:** Pressurized water reactor, Boiling water reactor,

sodium-graphite reactor, fast Breeder Reactor, Homogeneous Reactor, Gas cooled Reactor, Radiation hazards and shielding — radioactive waste disposal.

**UNIT – V:**

**Power Plant Economics and Environmental Considerations:** Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, Load curves, load duration curve. Definitions of connected load, Maximum demand, demand factor, average load, load factor, diversity factor — related exercises. Effluents from power plants and Impact on environment — pollutants and pollution standards — Methods of Pollution control.

**TEXT BOOKS:**

1. Power Plant Engineering/ P. K. Nag / Mc Graw Hill
2. Power Plant Engineering / Hegde / Pearson.

**REFERENCES BOOKS:**

1. Power Plant Engineering / Gupta / PHI
2. Power Plant Engineering / A K Raja / New age

## 22ME73B-PE: AUTOMOBILE ENGINEERING (PROFESSIONAL ELECTIVE – III)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Course Objectives:** The Objective of this course is to provide the student to

- Elaborate the Systems of Automobile, Components of Engine, fuel & Lubrication system and its requirements
- Explain the significance and features of Cooling, Ignition and Electrical Systems
- Illustrate the working of transmission system and Suspension systems and its components
- Elaborate the function of each accessory of steering and braking system and their role for effective performance of automobile
- Discuss the particulates of combustion in CI and SI engines, reasons for formation of particulates and methods adopted to control the pollution

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

- Illustrate the function of each and every system of an automobiles including fuel system and injection approaches
- Explain the Cooling, ignition and electrical system of the Automobile
- Describe each component of transmission system of an automobile viz clutch, gear box, propeller shaft and differential and suspension system and the effect of the same on tyre performance and other components of an automobile
- Analyze the geometry of the steering mechanism and braking system
- Demonstrate about emission standards, emission control techniques and electrical systems. Student can identify thrust areas for carrying their dissertation in future.

### UNIT – I:

**Introduction:** Layout of automobile – introduction chassis and body components. Types of Automobile engines. – Power unit – Introduction to engine lubrication – engine servicing

**Fuel System:** S.I. Engine: Fuel supply systems, Mechanical and electrical fuel pump – filters – carburetor – types – air filters – petrol injection. Introduction to MPFI and GDI Systems.

**C.I. Engines:** Requirements of diesel injection systems, types of injection systems, DI Systems IDI systems. Fuel pump, nozzle, spray formation, injection timing, testing of fuel pumps. Introduction to CRDI and TDI Systems.

### UNIT – II:

**Cooling System:** Cooling Requirements, Air Cooling, Liquid Cooling, Thermo, water and Forced Circulation System – Radiators – Types – Cooling Fan - water pump, thermostat, evaporative cooling

– pressure sealed cooling – antifreeze solutions.

**Ignition System:** Function of an ignition system, battery ignition system, constructional features of storage, battery, auto transformer, contact breaker points, condenser, and spark plug – Magneto coil ignition system, electronic ignition system using contact breaker, electronic ignition using contact triggers – spark advance and retard mechanism.

**Electrical System:** Charging circuit, generator, current – voltage regulator – starting system, bendix drive mechanism solenoid switch, lighting systems, Horn, wiper, fuel gauge – oil pressure gauge, engine temperature indicator etc.

### UNIT – III:

**Transmission System:** Clutches, principle, types, cone clutch, single plate clutch, multi plate clutch, magnetic and centrifugal clutches, fluid fly wheel – gear boxes, types, sliding mesh, constant mesh, synchro mesh gear boxes, epicyclic gear box, over drive torque converter. Propeller shaft – Hotch – Kiss drive, Torque tube drive, universal joint, differential rear axles – types – wheels and tyres.

**Suspension System:** Objects of suspension systems – rigid axle suspension system, torsion bar, shock absorber, independent suspension system.

#### **UNIT – IV:**

**Braking System:** Mechanical brake system, Hydraulic brake system, Master cylinder, wheel cylinder tandem master cylinder Requirement of brake fluid, Pneumatic and vacuum brakes.

**Steering System:** Steering geometry – camber, castor, king pin rake, combined angle toein, center point steering. Types of steering mechanism – Ackerman steering mechanism, Davis steering mechanism, steering gears – types, steering linkages.

#### **UNIT – V:**

Emissions from Automobiles – Pollution standards National and international – Pollution Control – Techniques – Multipoint fuel injection for SI Engines. Common rail diesel injection Energy alternatives

– Solar, Photo-voltaic, hydrogen, Biomass, alcohols, LPG, CNG, liquid Fuels, and gaseous fuels, Hydrogen as a fuel for IC Engines. - Their merits and demerits. Standard Vehicle maintenance practice.

#### **TEXT BOOKS:**

1. Automobile Engineering / William H Crouse
2. A Text Book Automobile Engineering–Manzoor, Nawazish Mehdi & Yosuf Ali, Frontline Publications.

#### **REFERENCE BOOKS:**

1. A Text Book of Automobile Engineering by R K Rajput. Laxmi Publications.
2. Automotive Mechanics / Heitner
3. Automotive Engineering / Newton Steeds & Garrett
4. Automotive Engines / Srinivasan.
5. A Text Book of Automobile Engineering By Khalil U Siddiqui New Age International



## 22ME73C-PE: NON-CONVENTIONAL ENERGY SOURCES (PROFESSIONAL ELECTIVE – III)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Course Objectives:** The Objective of this course is to

- Introduce the need of the non-convectional energy sources.
- Differentiate various solar collectors
- Identify the energy resources utilization systems
- Recognize the source and potential of wind energy and understand the classifications of wind mills.
- Summarize the principles of bio-conversion, ocean energy and geo thermal energy.

**Course Outcomes:** At the end of the course students will be able to

- Choose the appropriate renewable energy as an alternate for conventional power in any application.
- Understand principles of various solar collectors and use them in different applications
- Inculcate the knowledge on usage of alternate energy sources in I.C Engines
- Know various energy conversion techniques
- Analyze large scale demand of heat energy for meeting day to day domestic, institutional and industrial requirements can be met by utilizing solar thermal systems, biogas, PV cells, wind energy, Geothermal, MHD etc.

### UNIT-I:

Principles of Solar Radiation, Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power - Physics of the sun, the solar constant, extra-terrestrial and terrestrial solar radiation, Solar radiation on tilted surface, Instruments for measuring solar radiation and sun shine, solar radiation data.

### UNIT-II:

Solar Energy Collection Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors. Solar Energy Storage and Applications: Different methods, sensible, latent heat and stratified storage, solar ponds. Solar applications - solar heating/ cooling techniques, solar distillation and drying, Photovoltaic energy conversion.

### UNIT-III:

Wind Energy Sources and potentials, horizontal and vertical axis windmills, performance characteristics. Bio-Mass: Principles of Bio-Conversion, Anaerobic /aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C. Engine operation, and economic aspects.

**UNIT-IV:** Geothermal Energy Resources, types of wells, methods of harnessing the energy, potential in India. OTEC: Principles, utilization, setting of OTEC plants, thermodynamic cycles. Tidal and Wave Energy: Potential and conversion techniques, mini-hydel power plants, their economics.

**UNIT-V:**

Direct Energy Conversion Need for DEC, Carnot cycle, limitations, Principles of DEC. Thermo-electric generators, Seebeck, Peltier and Joule Thompson effects, figure of merit, materials, applications, MHD generators, principles, dissociation and ionization, hall effect, magnetic flux, MHD accelerator, MHD engine, power generation systems, electron gas dynamic conversion, economic aspects. Fuel cells, principle, faraday's laws, thermodynamic aspects, selection of fuels and operating conditions.

**TEXT BOOKS:**

1. Renewable Energy Sources/Twidell & Weir /Taylor and Francis / 2nd Special Indian Edition.
2. Non- conventional Energy Sources / G.D. Rai / Dhanpat Rai and Sons.

**REFERENCE BOOKS:**

1. Energy Resources Utilization and Technologies/Anjaneyulu & Francis/BS Publications/2012.
2. Principles of Solar Energy / Frank Krieth & John F Kreider / Hemisphere Publications.
3. Non-Conventional Energy / Ashok V Desai / Wiley Eastern.
4. Non-Conventional Energy Systems / K Mittal / Wheeler.
5. Renewable Energy Technologies /Ramesh & Kumar /Narosa.
6. Renewable Energy Resources /Tiwari and Ghosal /Narosa.

## 22ME73D-PE: SOLAR ENERGY TECHNOLOGY (PROFESSIONAL ELECTIVE – III)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

### Course Objectives

- Focus on solar energy utilization
- Explain the concepts of solar water heating and its layout
- Concepts of thermal energy storage
- Discuss the energy conversion technologies
- Concentrate the economic aspects of Solar Energy

### Course Outcomes

- Explain the solar energy potential and construction details of collector with performance analysis
- Analyse the concepts of solar water heating technologies and its parameters
- Narrate the methods of solar energy storage and its working
- Infer the direct energy conversion and conversion efficiencies calculations
- Discuss the Principles of Economic Analysis and optimization with respect solar energy

### UNIT- I:

**Introduction** – Solar energy option, specialty and potential – Sun – Earth – Solar radiation, beam and diffuse – measurement – estimation of average solar radiation on horizontal and tilted surfaces – problems – applications. Capturing solar radiation – physical principles of collection – types – liquid flat plate collectors – construction details – performance analysis – concentrating collection – flat plate collectors with plane reflectors – cylindrical parabolic collectors – Orientation and tracking – Performance Analysis.

### UNIT- II:

**Design of Solar Water Heating System and Layout:** Power generation – solar central receiver system – Heliostats and Receiver – Heat transport system – solar distributed receiver system – Power cycles, working fluids and prime movers, concentration ratio.

### UNIT- III:

**Thermal Energy Storage:** Introduction – Need for – Methods of sensible heat storage using solids and liquids – Packed bed storage – Latent heat storage – working principle – construction – application and limitations. Other solar devices – stills, air heaters, dryers, Solar Ponds & Solar Refrigeration, active and passive heating systems.

### UNIT- IV:

**Direct Energy Conversion:** solid-state principles – semiconductors – solar cells – performance – modular construction – applications. conversion efficiencies calculations.

### UNIT- V:

**Economics:** Principles of Economic Analysis – Discounted cash flow – Solar system – life cycle costs – cost benefit analysis and optimization – cost-based analysis of water heating and photo voltaic applications.

### TEXT BOOKS:

1. Principles of solar engineering/ Kreith and Kerider/Taylor and Francis/2<sup>nd</sup> Edition.
2. Solar energy thermal processes/ Duffie and Beckman/John Wiley & Sons

### REFERENCE BOOKS:

1. Solar energy: Principles of Thermal Collection and Storage/ Sukhatme/TMH/2nd edition
2. Solar energy/ Garg/TMH 5. Solar energy/ Magal/Mc Graw Hill
3. Solar Thermal Engineering Systems / Tiwari and Suneja/Narosa
4. Power plant Technology/ El Wakil/TMH.

## 22ME74A-PE: RE-ENGINEERING (PROFESSIONAL ELECTIVE – IV)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Course objective:** The objective is to understand the terminologies related to forward engineering and reverse engineering and to identify the process of designing, manufacturing, assembling, and maintaining products and systems.

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

- Familiarize with the process of reverse engineering and its applications.
- Understand the methodologies and techniques for Reverse Engineering.
- Learn various data collection techniques and the data processing chain.
- Select a proper system to generate geometric representations of physical objects.
- Integrate Reverse Engineering and Rapid Prototyping.

### UNIT - I

**Introduction to Reverse Engineering:** Reverse Engineering –The Generic Process  
Reverse Engineering in Automotive, Aerospace, Medical sectors: Legal Aspects of Reverse Engineering: Copyright Law, Reverse Engineering, Recent Case Law, Barriers to Adopting Reverse Engineering. A discussion on a few benchmark case studies

### UNIT - II

**Methodologies and Techniques for Reverse Engineering:** The Potential for Automation with 3-D Laser Scanners, What Is Not Reverse Engineering, What is Computer-aided (Forward) Engineering, What Is Computer-aided Reverse Engineering, Computer Vision and Reverse Engineering, Structured- light Range Imaging, Scanner Pipeline

### UNIT - III

**Reverse Engineering–Hardware and Software:** Contact Methods Noncontact Methods, Destructive Method. Reverse Engineering Software Classification, Fundamental Reverse Engineering Operations, Reverse Engineering Phases

### UNIT - IV

**Selecting a Reverse Engineering System:** The Selection Process, Some Additional Complexities, Point Capture Devices, Triangulation Approaches, “Time-of-flight” or Ranging Systems, Structured-light and Stereoscopic Imaging Systems, issues with Light-based Approaches, Tracking Systems, Internal Measurement Systems, X-ray Tomography, Destructive Systems, Some Comments on Accuracy, Positioning the Probe, Post processing the Captured Data, Handling Data Points, Curve and Surface Creation, Inspection Applications, Manufacturing Approaches.

### UNIT - V:

**Integration between Reverse Engineering and Rapid Prototyping:** Modeling Cloud Data in Reverse Engineering, Data Processing for Rapid Prototyping, Integration of RE and RP for Layer-based Model Generation, Adaptive Slicing Approach for Cloud Data Modeling, Planar Polygon Curve Construction for a Layer, Determination of Adaptive Layer Thickness.

**TEXT BOOK:**

1. Reverse Engineering: An Industrial Perspective by Vinesh Raja and Kiran J. Fernandes, Springer-Verlag London Limited 2008

**REFERENCE BOOKS:**

1. K. Otto and K. Wood, Product Design: Techniques in Reverse Engineering and New Product Development, Prentice Hall, 2001.
2. Anupam Saxena, Birendra Sahay, Computer Aided Engineering Design, Springer, 2005.
3. Ali K. Kamrani and Emad Abouel Nasr, Engineering Design and Rapid Prototyping, Springer, 2010.

## 22ME74B-PE: COMPUTATIONAL FLUID DYNAMICS (PROFESSIONAL ELECTIVE – IV)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Pre-requisite:** Heat Transfer and Fluid Mechanics

**Course Objective:** To apply the principles of Heat Transfer and Fluid Mechanics to formulate governing equations for physical problems and to solve those using different numerical techniques

**Course Outcomes:** At the end of the course, the student should be able to:

- Differentiate between different types of Partial Differential Equations and to know and understand appropriate numerical techniques.
- Solve the simple heat transfer and fluid flow problems using different numerical techniques, viz., FDM.
- Understand and to appreciate the need for validation of numerical solution.

### UNIT - I:

Basic Aspects of the Governing Equations – Physical Boundary Conditions – Methods of solutions of Physical Problems – Need for Computational Fluid Dynamics – Different numerical/CFD techniques – FDM, FEM, FVM etc., - Main working principle - CFD as a research and design tool – Applications in various branches of Engineering

Mathematical behavior of Partial Differential Equations (Governing Equations): Classification of linear/quasi linear PDE – Examples - Physical Processes: Wave Equations and Equations of Heat Transfer and Fluid Flow – Mathematical Behavior - General characteristics – Its significance in understanding the physical and numerical aspects of the PDE – One way and Two Way variables – Well posed problems – Initial and Boundary Conditions

Solution of Simultaneous Algebraic Equations: Direct Method – Gauss Elimination – LU Decomposition – Pivoting – Treatment of Banded Matrices – Thomas Algorithm  
Iterative Method: Gauss Seidel and Jordan Methods - Stability Criterion

### UNIT - II:

Finite Difference Method: Basic aspects of Discretization – Finite Difference formulae for first order and second order terms — Solution of physical problems with Elliptic type of Governing Equations for different boundary conditions - Numerical treatment of 1D and 2D problems in heat conduction, beam etc., - Solutions – Treatment of Curvilinear coordinates – Singularities – Finite Difference Discretization  
– Solution of 1D heat conduction problems in Heat conduction in curve linear coordinates

### UNIT - III:

FDM: Solution of physical problems with Parabolic type of Governing Equations – Initial Condition – Explicit, implicit and semi implicit methods – Types of errors – Stability and Consistency – Von Neumann Stability criterion – Solution of simple physical problems in 1D and 2D – Transient Heat conduction problems- ADI scheme - Simple Hyperbolic type PDE - First order and Second order wave equations – Discretization using Explicit method - Stability criterion – Courant Number – CFL Condition - Its significance - Treatment of simple problems

**UNIT - IV:**

Finite Difference Solution of Unsteady Inviscid Flows: Lax – Wendroff Technique – Disadvantages –Maccormack’s Technique

Fluid Flow Equations – Finite Difference Solutions of 2D Viscous Incompressible flow problems – Vorticity and Stream Function Formulation – Finite Difference treatment of Lid Driven Cavity Problem -Application to Cylindrical Coordinates with example of flow over infinitely long cylinder and sphere – Obtaining Elliptic Equations

**UNIT - V:**

Finite Difference Applications in Fluid flow problems: Fundamentals of fluid Flow modeling using Burger’s Equation – Discretization using FTCS method with respect to Upwind Scheme and TransportProperty – Upwind Scheme and Artificial Viscosity

Solutions of Navier Stokes Equations for Incompressible Fluid Flows: Staggered Grid – Marker and Cell (MAC) Formulation – Numerical Stability Considerations – Pressure correction method - SIMPLE Algorithm

**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

**REFERENCE BOOKS:**

1. Computational Fluid Flow and Heat Transfer / K Muralidharan and T Sudarajan/ Narosa Publishers.
2. Computational Methods for Fluid Dynamics / Firziger & Peric/ Springer



## 22ME74C-PE: TURBO MACHINERY (PROFESSIONAL ELECTIVE – IV)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Pre-requisites:** Thermal Engineering, Heat Transfer

### Course Objectives:

- To provide the knowledge of basic principles, governing equations and applications of turbo machinery.
- To explain construction and working principle and evaluate the performance characteristics of Turbo Machines

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

- Apply thermodynamics and kinematics principles to turbo machines
- Understand mechanisms behind working of Turbines, compressors.
- Understand the thermodynamic and flow analysis for turbines and compressors
- Analyze the performance of turbo machines.

### UNIT – I:

**Introduction to Turbomachinery:** Classification of turbo-machines, second law of thermodynamics applied to turbine and compressors work, nozzle, diffuser work, fluid equation, continuity, Euler's, Bernoulli's, equation and its applications, expansion and compression process, reheat factor, preheat factor

### UNIT – II:

**Fundamental Concepts of Axial and Radial Machines:** Euler's equation of energy transfer, vane congruent flow, influence of relative circulation, thickness of vanes, number of vanes on velocity triangles, slip factor, Stodola, Stanitz and Balje's slip factor, suction pressure and net positive suction head, phenomena of cavitation in pumps, concept of specific speed, shape number, axial, radial and mixed flow machines, similarity laws.

### UNIT – III:

**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.

**Centrifugal compressor:** Types, Velocity triangles and efficiencies, Blade passage design, Diffuser and pressure recovery. Slip factor, Stanitz and Stodolas formula's, Effect of inlet mach numbers, Pre whirl, Performance

### UNIT – IV:

**Axial Flow Compressors:** Flow Analysis, Work, and velocity triangles, Efficiencies, Thermodynamic analysis. Stage pressure rise, Degree of reaction, Stage Loading, General design, Effect of velocity, Incidence, Performance

**Cascade Analysis:** Geometrical and terminology. Blade force, Efficiencies, Losses, Free end force, Vortex Blades.

**UNIT – V:** Axial Flow Gas Turbines: Work done. Velocity triangle and efficiencies, Thermodynamic flow analysis, Degree of reaction, Zweifel's relation, Design cascade analysis, Soderberg, Hawthorne, Ainley, Correlations, Secondary flow, Free vortex blade, Blade angles for variable degree of reaction. Actuator

disc, Theory, Stress in blades, Blade assembling, Material and cooling of blades, Performances, Matching of compressors and turbines, off design performance.

**TEXT BOOKS:**

1. Principles of Turbo Machines/DG Shepherd / Macmillan
2. Turbines, Pumps, Compressors/Yahya/ Mc Graw Hill

**REFERENCE BOOKS:**

1. A Treatise on Turbo machines / G. Gopal Krishnan *and* D. Prithviraj/ SciTech
2. Gas Turbine Theory/ Saravanamuttoo/ Pearson.
3. Turbo Machines/ A Valan Arasu/ Vikas Publishing House Pvt. Ltd.

## 22ME74D-PE: FLUID POWER SYSTEM (PROFESSIONAL ELECTIVE – IV)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Pre-requisites:** Fluid Mechanics and Hydraulics Machinery

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

- Understand the basic types of pumps and motors
- Analyse different types of valves
- Design and analysis of hydraulic circuits
- Visualize how a hydraulic/pneumatic circuit works to accomplish the function.
- Design an appropriate hydraulic or pneumatic circuit or combination circuit like electro-hydraulics, electro-pneumatics for a given application.

### UNIT- I:

Introduction to oil hydraulics and pneumatics, their structure, advantages and limitations. ISO symbols, energy losses in hydraulic systems. Applications, Basic types and constructions of Hydraulic pumps and motors. Pump and motor analysis. Performance curves and parameters.

### UNIT- II:

Hydraulic actuators, types and constructional details, lever systems, control elements — direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves. Flapper valve Analysis and Design.

### UNIT- III:

Proportional control valves and servo valves. Nonlinearities in control systems (backlash, hysteresis, dead band and friction nonlinearities). Design and analysis of typical hydraulic circuits. Regenerative circuits, high low circuits, Synchronization circuits, and accumulator sizing.

### UNIT- IV:

Intensifier circuits Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits, accessories used in fluid power system, Filtration systems and maintenance of system. Components of pneumatic systems; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits. Valves for logic functions; Time delay valve; Exhaust and supply air throttling;

### UNIT- V:

Examples of typical circuits using Displacement — Time and Travel-Step diagrams. Will-dependent control, Travel-dependent control and Time dependent control, combined control, Program Control, Electropneumatic control and air-hydraulic control, Ladder diagrams. Applications in Assembly, Feeding, Metal working, materials handling and plastics working.

**TEXT BOOKS:**

1. Fluid Power Control systems/ Pippenger, J.J., and R. M. Koff/ New York: McGraw Hill.
2. Fluid Power Systems: modeling, simulation and microcomputer control"/ John Watton/ Prentice Hall International.

**REFERENCE BOOKS:**

1. Fundamentals of Fluid Power Control. / John Watton/ 1<sup>st</sup> Ed. Cambridge University Press, 2009.
2. Fluid Power with applications"/ Anthony Esposito / Pearson Education.

**22ME721-OE: QUANTITATIVE ANALYSIS FOR BUSINESS  
DECISIONS(OPEN ELECTIVE – II)**

**B.Tech. IV Year, I Sem.**

L	T	P	C
3	0	0	3

**Course Objectives:**

- To impart knowledge of basic tools of Operations research in solving the management problems using mathematical approaches for decision making.
- To teach the methods of solving Linear Programming Problems.
- To impart knowledge on assignment model and transportation problem.
- To impart knowledge on the significance of decision tree and Network analysis.
- To highlight the importance of Queuing Theory.

**Course Outcomes:** At the end of the course, students will be able to:

- Understand the origin and application of operations research.
- Learn about the Formulation of Linear Programming Problem for different areas.
- appreciate the significance of variations of assignment problem, methods for finding Initial feasible solution.
- Learn the aspects of Decision Theory and Network Analysis
- Gain insights of the theoretical principles and practical applications of different queuing models.

**UNIT – I: Introduction to Operations Research:** Nature and Scope of Operations Research: Origins of OR, Applications of OR in different Managerial Areas, Problem Solving and Decision- making, Quantitative and Qualitative Analysis. Defining a Model, Types of Models, Process for Developing an Operations Research Model, Practices, Opportunities and Shortcomings of usingan OR Model.

**UNIT – II: Linear Programming Method:** Structure of LPP, Assumptions of LPP, Application Areas of LPP, Guidelines for Formulation of LPP, Formulation of LPP for Different Areas, Solving of LPP by Graphical Method: Extreme Point Method, Simplex Method, Converting Primal LPP to Dual LPP, Limitations of LPP.

**UNIT – III: Assignment Model:** Algorithm for Solving Assignment Model, Hungarians Method for Solving Assignment Problem, Variations of Assignment Problem: Multiple Optimal Solutions, Maximization Case in Assignment Problem, Unbalanced Assignment Problem, Travelling Salesman Problem, Simplex Method for Solving Assignment Problem.

**Transportation Problem:** Mathematical Model of Transportation Problem, Methods for Finding Initial Feasible Solution: Northwest Corner Method, Least Cost Method, Vogels Approximation Method, Test of Optimality by Modi Method, Unbalanced Supply and Demand, Degeneracy and itsResolution.

**UNIT – IV: Decision Theory:** Introduction, Ingredients of Decision Problems. Decision-making under Uncertainty, Cost of Uncertainty Under Risk, Under Perfect Information, Decision Tree, Construction of Decision Tree.

Network Analysis: Network Diagram, PERT, CPM, Critical Path Determination, Project CompletionTime, Project Crashing.

**UNIT – V: Queuing Theory:** Queuing Structure and Basic Component of a Queuing Model, Distributions in Queuing Model, Different Queuing Models with FCFS, Queue Discipline, Single and Multiple Service Station with Finite and Infinite Population. Game Theory, Saddle Point, Value of the Game.

**TEXT BOOKS:**

1. Mik Wisniewski, Dr Farhad Shafiq, Quantitative Analysis for Decision Makers, Pearson, 7e, 2019.
2. Miguel Ángel Canela, Inés Alegre, Alberto Ibarra, Quantitative Methods for Management: A Practical Approach, Springer International Publishing, 1e, 2019.

**REFERENCE BOOKS:**

1. James E. Sallis, Geir Gripsrud, Ulf Henning Olsson, Ragnhild Silkoset, Research Methods and Data Analysis for Business Decisions: A Primer Using SPSS, Springer International Publishing, 1e, 2021.
2. R. Pannerselvam, Operations Research, Prentice Hall International, 3e, 2015.
3. N.V.S. Raju, Operations Research: Theory and Practice, CRC Press, 2020.
4. R. Pannerselvam, Operations Research, Prentice Hall International, 3e, 2015
5. J.K. Sharma, Operations Research: Theory and applications, MacMillan, 5e, 2013.

## 22ME722-OE: INDUSTRIAL ENGINEERING & MANAGEMENT (OPEN ELECTIVE – II)

B.Tech. IV Year, I Sem.

L	T	P	C
3	0	0	3

**Prerequisites:** None

**Course objectives:** The main objectives of this course are the following to Learn:

- Philosophies of various management gurus & characteristics of various organization structures
- Various Industrial Engineering practices
- Human resource management practices
- Network analysis through PERT and CPM techniques

**Course outcomes:** At the end of course, students will be able to

- Practice the management theories proposed by Taylor, Fayol etc
- Consider various factors and identify plant location for given industry.
- Determine EOQ, classify items and implement P-system and Q-system
- Conduct work study (method study+ Work measurement: a) Time study & Work sampling))
- Practice HRM principles
- Analyze the networks by using PERT & CPM

### UNIT - I:

**Management and Organization** – Functions of Management - Contributions of Taylor, Fayol, Douglas Mc-Gregor, Mayo Hertzberg and Maslow. — Systems Approach to Management - Organizational Structures: Basic concepts related to Organization - Departmentation and Decentralization, Types of mechanistic and organic structures of organization and their merits, demerits and suitability.

### UNIT- II:

**Operations Management-I:** Plant location, definition, factors affecting the plant location, comparison of rural and urban sites-methods for selection of plant- Matrix approach. Types of plant layout – various data analyzing forms-travel chart - Work study: Method study and Work measurement. Inventory — functions, types, Determination of Economic Order Quantity (EOQ), ABC and VED analysis. Inventory Control Systems-Continuous review system-periodical review system. Stores Management and Stores Records. Purchase management, duties of purchase of manager, JIT System.

### UNIT - III:

**Operations Management-II:** Inspection and quality control, types of inspections - Statistical Quality Control-techniques- Charts for variables and attributes. Acceptance sampling plan- single sampling and double sampling plans-OC curves. Introduction to TQM- Quality Circles, ISO 9000 series procedures. Functions of Marketing, Marketing vs Selling, Marketing mix, Product Life Cycle.

### UNIT - IV:

**Human Resources Management (HRM):** Concepts of HRM, HRD and Personnel Management and Industrial Relations (PMIR), HRM vs PMIR, Basic functions of HR Manager: Manpower planning, Recruitment, Selection, Training and Development, Placement, Wage and Salary Administration, Promotion, Transfer, Separation, Performance Appraisal, Grievance Handling and Welfare Administration, Job Evaluation and Merit Rating — Capability Maturity Model (CMM) Levels —

Performance Management System.

**UNIT- V:**

**PERT/CPM:** Project management, network modelling-probabilistic model, various types of activity time's estimation-programme evaluation review techniques- Critical Path-probability of completing the project, Critical Path Method (CPM) - Project crashing. Simple problems.

**TEXT BOOKS:**

1. Aryasri, Management Science, McGraw hill, 2012
2. Kumar, Rao and Chhalill: Introduction to Management Science, Cengage 2012.

**REFERENCE BOOKS:**

1. Stoner, Freeman, Gilbert, Management, Pearson Education, New Delhi, 2012.
2. Amrine, Manufacturing Organization and Management, Pearson, 2012.
3. Chase, Jacobs, Aquilano, Operations Management, McGraw Hill, 2012.
4. Panner Selvam, Production and Operations Management, PHI, 2012.
5. Nadha Muni Reddy & Vijaya Kumar Reddy, Reliability Engineering & Quality Engineering, Galgotia, 2012.
6. Ralph M Barnes, Motion and Time Studies, John Wiley and Sons, 2012.
7. L. S. Srinath, PERT / CPM, Affiliate East-West Press, New Delhi, 2012.
8. Gary Dessler, Human Resource Management, Pearson Education Asia, 2012.
9. Phillip Kotler, Marketing Management, Pearson, 2012.
10. S. K. Basu, K. C. Sahu, B. Rajiv: Industrial Organization and Management, PHI, 2012.
11. Dipak Kumar Bhattacharyya: Industrial Management, Vikas publishing house 2013.



## 22ME85A-PE: INDUSTRIAL ROBOTICS (PROFESSIONAL ELECTIVE – V)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

**Pre-requisites:** Basic principles of Kinematics and mechanics

**Course Objectives:** The goal of the course is to familiarize the students with the concepts and techniques in robotic engineering, manipulator kinematics, dynamics and control, chose, and incorporate robotic technology in engineering systems.

- Make the students acquainted with the theoretical aspects of Robotics
- Enable the students to acquire practical experience in the field of Robotics through design projects and case studies.
- Make the students to understand the importance of robots in various fields of engineering.
- Expose the students to various robots and their operational details.

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

- understand the basic components of robots.
- Differentiate types of robots and robot grippers.
- Model forward and inverse kinematics of robot manipulators.
- Analyze forces in links and joints of a robot.
- Programme a robot to perform tasks in industrial applications.
- Design intelligent robots using sensors.

### UNIT – I:

**Introduction:** Automation and Robotics – An over view of Robotics – present and future applications. **Components of the Industrial Robotics:** common types of arms. Components, Architecture, number of degrees of freedom — Requirements and challenges of end effectors, Design of end effectors, Precision of Movement: Resolution, Accuracy and Repeatability, Speed of Response and Load Carrying Capacity.

### UNIT – II:

**Motion Analysis:** Basic Rotation Matrices, Equivalent Axis and Angle, Euler Angles, Composite Rotation Matrices. Homogeneous transformations as applicable to rotation and translation – problems. **Manipulator Kinematics**-H notation-H method of Assignment of frames-H Transformation Matrix, joint coordinates and world coordinates, Forward and inverse kinematics – problems on Industrial Robotic Manipulators.

### UNIT – III:

Differential transformation of manipulators, Jacobians – problems. Dynamics: Lagrange – Euler and Newton — Euler formations — Problems.

Trajectory planning and avoidance of obstacles, path planning, Slew motion, joint interpolated motion – straight line motion.

### UNIT – IV:

**Robot actuators and Feedback components:** Actuators: Pneumatic, Hydraulic actuators, electric & stepper motors, comparison of Actuators, Feedback components: position sensors – potentiometers, resolvers, encoders – Velocity sensors, Tactile and Range sensors, Force and Torque sensors – End Effectors and Tools

**UNIT V:**

**Robot Application in Manufacturing:** Material Transfer - Material handling, loading and unloading-Processing - spot and continuous arc welding & spray painting - Assembly and Inspection. Robotic Programming Methods – Languages: Lead Through Programming, Textual Robotic Languages such as APT, MCL.

**TEXT BOOKS:**

1. Industrial Robotics / Groover M P /Mc Graw Hill
2. Introduction to Industrial Robotics / Ramachandran Nagarajan / Pearson

**REFERENCE BOOKS:**

1. Robot Dynamics and Controls / Spony and Vidyasagar / John Wiley
2. Robot Analysis and control / Asada, Slotine / Wiley Inter-Science.
3. Robotics – Fu et al / TMH Publications.

## 22ME85B-PE: MECHANICAL VIBRATIONS (PROFESSIONAL ELECTIVE – V)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

**Pre-requisites:** Engineering Mechanics.

**Course objectives:** To Understand various types of vibrations.

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

- Understand the causes and effects of vibration in mechanical systems.
- Develop schematic models for physical systems and formulate governing equations of motion
- Understand the role of damping, stiffness and inertia in mechanical systems
- Analyze rotating and reciprocating systems and compute critical speeds.
- Analyze and design machine supporting structures, vibration isolators and absorbers.

### UNIT – I:

**Single degree of Freedom systems - I:** Undamped and damped free vibrations; forced vibrations coulomb damping; Response to excitation; rotating unbalance and support excitation; vibration isolation and transmissibility.

### UNIT – II:

**Single degree of Freedom systems - II:** Response to Non-Periodic Excitations: unit impulse, unit step and unit Ramp functions; response to arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method.

### UNIT – III:

**Two-degree freedom systems:** Principal modes- undamped and damped free and forced vibrations; undamped vibration absorbers;

**Multi degree freedom systems:** Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi- rotor systems and geared systems; Discrete- Time systems.

### UNIT – IV:

**Continuous system:** Free vibration of strings – longitudinal oscillations of bars- traverse vibrations of beams- Torsional vibrations of shafts.

**Critical speeds of shafts:** Critical speeds without and with damping, secondary critical speed.

**Numerical Methods:** Rayleigh's stodola's, Matrix iteration, Rayleigh- Ritz Method and Holzer's methods.

Vibration measuring instruments: Vibrometers, velocity meters & accelerometers

### UNIT – V:

**Sound level and subjective response to sound:** Subjective response to sound, frequency dependent human response to sound, sound-pressure dependent human response, the decibel scale, relationship among sound power, sound intensity and sound pressure level, relationship between sound power level and sound intensity, relationship between sound intensity level and sound pressure level, sound measuring instruments.

**TEXT BOOKS:**

1. Elements of Vibration Analysis / Meirovitch/ Mc Graw Hill
2. Principles of Vibration / Benson H. Tongue/Oxford

**REFERENCE BOOKS:**

1. Mechanical Vibrations / SS Rao / Pearson
2. Mechanical Vibration /Rao V. Dukkipati, J Srinivas/ PHI.
3. Mechanical Vibrations/ G.K. Grover/ Nemchand & Brothers.

## 22ME85C-PE: COMPOSITE MATERIALS (PROFESSIONAL ELECTIVE – V)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

### Course objectives:

- Develop understanding of the structure of ceramic materials on multiple length scales.
- Develop knowledge of point defect generation in ceramic materials, and their impact on transport properties.
- To describe key processing techniques for producing metal, ceramic-, and polymer-matrix composites.
- To demonstrate the relationship among synthesis, processing, and properties in composite materials.

**Course Outcomes:** At the end of the course student will be able to

- Understand the crystal structures of a wide range of ceramic materials and glasses.
- explain how common fibers are produced and how the properties of the fibers are related to the internal structure.
- select matrices for composite materials in different applications.
- describe key processing methods for fabricating composites.

### UNIT – I:

Introduction: Definition, Classification of Composite materials based on structure, based on matrix, Advantages of composites, Applications of composites, Functional requirements of reinforcement and matrix.

### UNIT – II:

Types of reinforcements and their properties: Fibers: Carbon, Boron, Glass, Aramid,  $\text{Al}_2\text{O}_3$ , SiC, Nature and manufacture of glass, carbon and aramid fibres, Comparison of fibres. Role of interfaces: Wettability and Bonding, The interface in Composites, Interactions and Types of bonding at the Interface, Tests for measuring Interfacial strength.

### UNIT – III:

Fabrication of Polymeric Matrix Composites, Structure and properties of Polymeric Matrix Composites, Interface in Polymeric Matrix Composites, Applications; Fabrication of Ceramic Matrix Composites, Properties of Ceramic Matrix Composites, Interface in Ceramic Matrix Composites, Toughness of Ceramic Matrix Composites Applications of Ceramic Matrix Composites.

### UNIT – IV:

Fabrication of Metal Matrix Composites: Solid state fabrication, Liquid state fabrication and In-situ fabrication techniques; Interface in Metal Matrix Composites: Mechanical bonding, Chemical bonding and Interfaces in In-situ Composites; Discontinuously reinforced Metal Matrix Composites, Properties and Applications. Fabrication of Carbon fiber composites, properties, interface and applications.

### UNIT – V:

Micromechanics of Composites: Density, Mechanical Properties: Prediction of Elastic constants, Micro mechanical approach, Halpin-Tsai equations, Transverse stresses; Thermal properties: Hydrothermal stresses and Mechanics of Load transfer from matrix to fiber.

**TEXTS BOOKS:**

1. Composite Materials – Science & Engineering, K.K. Chawla, Springer-Verlag, New York, 1987.
2. An Introduction to Composite Materials, Hull, Cambridge, 2nd Edt. 1997.

**REFERENCE BOOKS:**

1. Composites, Engineered Materials Handbook, Vol. 1, ASM International, Ohio, 1988.
2. Structure and Properties of Composites, Materials Science and Technology, Vol. 13, VCH, Weinheim, Germany, 1993.
3. Composite Materials: Engineering and Science, F.L. Matthews and R.D. Rawlings, Chapman & Hall, London, 1994.

## 22ME85D-PE: ENERGY CONSERVATION AND MANAGEMENT (PROFESSIONAL ELECTIVE – V)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

### Course Objectives:

- To understand the principles of energy conservation
- To understand thermal insulation & refractors.
- To know waste heat recovery systems.
- To gain knowledge about engineering economics.
- To impart knowledge Energy management programs.

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

- Understand the basic concept of energy conservation and its role in energy management.
- Focus on thermal Insulation & refractors, classification and applications.
- Discuss the energy conservation opportunities in the energy intensive industries by waste heat recovery system.
- Analyze the quantum of electrical energy that can be saved by the use of energy efficient lighting systems and energy audit parameters.
- Understand concept of Project management and energy management Programs

### UNIT-I:

**Energy Conservation:** Rules for efficient energy conservation – technologies for energy conservation – outline of waste heat and material reclamation, load management, alternate energy sources, and energy storage.

### UNIT-II:

**Thermal Insulation & Refractors:** Heat loss through un-insulated surfaces, effects of insulation on current carrying wires – economic thickness of insulation – critical radius of insulation – properties of thermal insulators – classification of insulation materials – classification of refractors – properties of refractors – criteria for good refractory material – applications of insulating & refractory materials.

### UNIT-III:

**Waste Heat Recovery Systems:** Guideline to identify waste heat – feasibility study of waste heat – shell and tube heat exchanger – thermal wheel – heat pipe heat exchanger – heat pump – waste heat boilers – incinerators.

Heat Recovery Systems & Heat Exchanger Networks: Liquid to liquid heat exchangers – gas to liquid heat recovery systems, regenerators, recuperators, rotating regenerators – miscellaneous heat recovery methods – selection of materials for heat exchangers – combined radiation and convective heat exchanger, U tube heat exchanger, tube heat exchanger, fluidized bed heat exchanger – economizer.

### UNIT-IV:

**Engineering Economics:** Managerial objectives, steps in planning – efficiency of organization- capital budgeting – classification of costs – interest – types – nominal and effective interest rates – discrete and continuous compounding – discounting - time value of money – cash flow diagrams – present worth factor, capital recovery factor, equal annual payments – equivalent between cash flows. **ENERGY AUDITING:** A definition – objectives – level of responsibility – control of energy – uses of energy – check lists –

energy conservation schemes – energy index – cost index – pie charts – sankey diagrams – load profiles – types of energy audits – questionnaire – energy audit of industries – general energy audit – detailed energy audit – energy saving potential.

**UNIT-V:**

**Project Management**

Method of investment appraisal – rate of return method, pay back method, net present value method (NPV) – adoption of the methods in energy conservation campaign – types of projects — propose of project management – classification – role and qualities of project manager – types of budgets - budget committee — budgeting.

Energy Management Programs: Necessary steps of energy management programme – concepts of energy management – general principles of energy management – energy management in manufacturing and process industries – qualities and functions of energy managers – duties of energy manager - language of energy manager – checklist for top management.

**TEXT BOOKS:**

1. Waste heat recovery systems -D.A. Reay/Pergmon Press.
2. Energy Management -W.R. Murphy & G. Mickay, Butterworths

**REFERENCE BOOKS:**

1. Energy Conservation -P.W.O' Callaghan, Pergamon Press 1981.
2. Engineering Heat Audits -C.P. Gupta & Rajendra Prakash, Nechand & Bros.
3. Hand book of energy audits -Albert Thumann, The F.Airmont Press Inc., Atlanta Georgia, 1979.
4. Energy Management Principles -Craig B. Smithm, Pergarmon Press.



## 22ME86A-PE: INDUSTRY 4.0 (PROFESSIONAL ELECTIVE – VI)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

**Course Objectives:** The objectives of this course are

- To understand the basics of Industry 4.0
- To understand the Business model and impact of IIoT
- To understand the concepts of virtual reality, lean manufacturing
- To gain knowledge of various sensors and actuators.
- To understand various data transmission technologies.

**Course Outcomes:** After completion of the course the student will be able to

- Explain Smart Business Perspective, Cyber security, Impacts of Industry 4.0.
- Understand the basics of the Industrial Internet of Things.
- Understand various key technologies.
- Implement various sensors and actuators.
- Understand different industrial transmission technologies and IIOT applications in real life

### UNIT – I:

**Industry 4.0 Basics:** Industrial revolution: Phases, Evolution of Industry4.0, Environmental impacts of industrial revolution, Applications, Design requirements, Drivers of Industry4.0, Sustainability Assessment of industries, Smart Business Perspective, Cyber security, Impacts of Industry 4.0.

### UNIT – II:

**Industrial Internet of Things- Basics:** IIoT and Industry 4.0, IIC, Industrial Internet Systems, Design of industrial internet systems, Impact of industrial internet, Benefits of industrial internet, Industrial sensing, Industrial Processes, Features of IIoT for industrial processes, Industrial plant–The future architecture, Digital Enterprise

**Business Models and Reference Architecture of IIoT:** Definition of a business model, Business models of IIoT, Industrial Internet Reference Architecture

### UNIT –III:

**Key Technologies:** Off-site Technologies, Cloud Computing, Fog Computing

**Key Technologies:** On-site Technologies, Augmented Reality, Virtual Reality, Smart factories, Lean manufacturing system, Big Data and Advanced Analytics

### UNIT –IV:

**Sensors:** Various sensor types and their underlying working principles, Characteristics of Sensors – Resolution, calibration, accuracy and others, Sensor Categories – Thermal, Mechanical, Electrical, Optical and Acoustic sensors.

**Actuators:** Thermal, Hydraulic, Pneumatic, Electro mechanical Actuator

### UNIT – V:

**Industrial Data Transmission and Acquisition:** Architecture of various data transmission technologies like Foundation Fieldbus, Profibus, Highway Addressable Remote Transducer (HART), Interbus, Bitbus, Digital STROM, Controller Area Network, and other recent and upcoming Technologies. Distributed Control System, SCADA and PLC System.

**IIOT Applications:** IoT Applications on Industrial automation, Factories and Assembly line, Plant Security and Safety, Transportation, Agriculture, Healthcare, Home Automation, Oil, Chemical and Pharmaceutical Industry and others.

**TEXT BOOKS:**

1. Introduction to Industrial Internet of Things and Industry 4.0 by Sudip Misra, Chandana Roy, Anandarup Mukherjee, CRC Press
2. Vijay Madiseti, Arshdeep Bahga, Internet of Things, "A Hands-on Approach", University Press.

**REFERENCE BOOKS:**

1. Dr. SRN Reddy, Rachit Thukral and Manasi Mishra, "Introduction to Internet of Things: A practical Approach", ETI Labs
2. Pethuru Raj and Anupama C. Raman, "The Internet of Things: Enabling Technologies, Platforms, and Use Cases", CRC Press
3. Adrian McEwen, "Designing the Internet of Things", Wiley.
4. Raj Kamal, "Internet of Things: Architecture and Design", McGraw Hill.
5. Cuno Pfister, "Getting Started with the Internet of Things", O Reilly Media

## 22ME86B-PE: FUZZY LOGIC AND ANN (PROFESSIONAL ELECTIVE – VI)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

**Prerequisite:** Operations research, Optimisation Techniques, Control Systems

**Course Objectives:** The goal of this course is to give a good basic understanding of Neural Networks and Fuzzy Logic. This course is mainly intended for engineers who desire to learn more about these techniques

**Course outcomes:** After completion of this course, the student will be able to

- Understand the concepts of neural networks and fuzzy logics
- Understand the topology of multi-layer perceptron, recurrent neural networks and Fuzzification & Defuzzification.
- Understand the basic structure and operation of Fuzzy logic control systems

### UNIT-I:

**Evolution of neural networks;** Artificial Neural Network: Basic model, Classification, Feed forward and Recurrent topologies, Activation functions; Learning algorithms: Supervised, Un-supervised and Reinforcement; Fundamentals of connectionist modeling: McCulloch – Pits model, Perceptron, Adaline, Madaline.

### UNIT-II:

**Topology of Multilayer perceptron,** Back propagation learning algorithm, limitations of Multilayer perceptron. Radial Basis Function networks: Topology, learning algorithm; Kohonen's self-organising network: Topology, learning algorithm; Bidirectional associative memory Topology, learning algorithm, Applications.

### UNIT-III:

**Recurrent neural networks:** Basic concepts, Dynamics, Architecture and training algorithms, Applications; Hopfield network: Topology, learning algorithm, Applications; Industrial and commercial applications of Neural networks: Semiconductor manufacturing processes, Communication, Process monitoring and optimal control, Robotics, Decision fusion and pattern recognition.

### UNIT-IV:

**Classical and fuzzy sets:** Introduction, Operations and Properties, Fuzzy Relations: Cardinality, Operations and Properties, Equivalence and tolerance relation, Value assignment: cosine amplitude and max-min method; Fuzzification: Membership value assignment- Inference, rank ordering, angular fuzzy sets. Defuzzification methods, Fuzzy measures, Fuzzy integrals, Fuzziness and fuzzy resolution; possibility theory and Fuzzy arithmetic; composition and inference; Considerations of fuzzy decision-making.

### UNIT-V:

**Basic structure and operation of Fuzzy logic control systems;** Design methodology and stability analysis of fuzzy control systems; Applications of Fuzzy controllers. Applications of fuzzy theory.

**TEXT BOOKS:**

1. Neural Networks in Computer Intelligence by Limin Fu, McGraw Hill, 2003.
2. Soft Computing and Intelligent Systems Design, Theory, Tools and Applications by Fakhreddine O. Karray and Clarence De Silva., Pearson Education, India, 2009.

**REFERENCE BOOKS:**

1. Fuzzy Logic with Engineering Applications by Timothy J. Ross, McGraw Hill, 1995.
2. Artificial Neural Networks by B. Yegnanarayana, PHI, India, 2006.

## 22ME86C-PE: ELECTRIC AND HYBRID VEHICLES (PROFESSIONAL ELECTIVE – VI)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

### Course Objectives:

- Explain the history of Electric vehicles and development
- Discuss the Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies
- Explore to basic concept of electric traction, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives etc.
- Analyse the Fuel Cell based energy storage and Super Capacitor based energy storage etc.
- Explore to types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others) etc.

**Course Outcomes:** At the end of the course student will be able to

- Choose the appropriate source of energy for the hybrid electric vehicle based on driving cycle.
- Analyze the power and energy need of the various hybrid electric vehicle and Measure and Estimate the energy consumption of the Hybrid Vehicles
- Evaluate energy efficiency of the vehicle for its drive trains
- Elaborate the types of storage systems such as battery based, fuel cell based etc.
- Explain the types of Driving Cycles, Fuel Cell EV, Solar Powered Vehicles

### UNIT- I:

**Introduction To Electric Vehicle:** History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today – Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.

### UNIT- II:

**Introduction To Hybrid and Electric Vehicles:** Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis

### UNIT- III:

**Electric Drive Trains:** Basic concept of electric traction, introduction to various electric drivetrain topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency

### UNIT- IV:

**Types of Storage Systems:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy

storage technology, Calculation for the rating.

**UNIT- V:**

**Modelling of Hybrid Electric Vehicle Range:** Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2 wheeler, 3 wheeler and 4 wheeler vehicles.

**TEXT BOOKS**

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.

**REFERENCE BOOKS**

1. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2016.
2. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2010.

## 22ME86D-PE: TOTAL QUALITY MANAGEMENT (PROFESSIONAL ELECTIVE – VI)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

### Course Objectives:

- Develop an understanding of the necessary information and skills needed to manage, control and improve quality practices in the organizations through TQM philosophy.
- To understand customer and supplier relationship and Bench marketing.
- Apply TQM in traditional organizations.
- Analysis of quality in cost and management.
- To understand various ISO around the world.

**Course Outcomes:** After completion of the course the student will be able to

- Understand the concept of TQM and various control charts
- To analyze the relationship between customer and supplier
- Implement TQM in an organization
- To evaluate the cost of quality
- Understand the third-party audit and documentation of various ISO audits

### UNIT – I:

Introduction: The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

### UNIT – II:

Customer Focus and Satisfaction: Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

### UNIT – III:

Organizing for TQM: The systems approach, organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

### UNIT – IV:

The Cost of Quality: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

### UNIT – V:

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-90. Series Standards, benefits of ISO9000 certification, the third-party audit, Documentation ISO9000 and services, the cost of certification implementing the system.

**TEXT BOOKS:**

1. Total Quality Management: Text, cases and Readings, Third Edition - Joel E. Ross.
2. Beyond TQM - Robert L. Flood.

**REFERENCE BOOKS:**

1. Statistical Quality Control – Eugene Grant, Richard McGraw-Hill, 2017.
2. Total Quality Management, Besterfiled D. H., Pearson Education Asia – 2015-4<sup>th</sup> Edition
3. The Management and Control of Quality, Evans J. R, and Lindsay W. M., Southwestern (Thomson Learning), Fifth Edition.



## 22ME831-OE: ENTREPRENEURSHIP DEVELOPMENT (OPEN ELECTIVE – III)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

**Course objectives:** • Study of this subject provides an understanding of the scope of an entrepreneur, key areas of development, financial assistance by the institutions, methods of taxation and tax benefits, etc.

**Course Outcomes:** • Upon completion of the course, students will be able to

- Identify the factors affecting entrepreneurial growth
- Understand various programs supporting entrepreneurship
- Write preliminary project report
- Estimate the finances for the project
- Appraise and avail support rendered by the Government and other Appropriate Agencies

### UNIT I

**Entrepreneurship** Entrepreneur – Types of Entrepreneurs – Difference between Entrepreneur and Intrapreneur Entrepreneurship in Economic Growth, Factors Affecting Entrepreneurial Growth.

### UNIT II

**Motivation** Major Motives Influencing an Entrepreneur – Achievement Motivation Training, Self Rating, Business Game, Thematic Apperception Test – Stress Management, Entrepreneurship Development Programs – Need, Objectives.

### UNIT III

**Business** Small Enterprises – Definition, Classification – Characteristics, Ownership Structures – Project Formulation – Steps involved in setting up a Business – Identifying, selecting a Good Business opportunity, Market Survey and Research, Techno Economic Feasibility Assessment – Preparation of Preliminary Project Reports – Project Appraisal – Sources of Information – Classification of Needs and Agencies.

### UNIT IV

**Financing and Accounting:** Need – Sources of Finance, Term Loans, Capital Structure, Financial Institution, Management of working Capital, Costing, Break Even Analysis, Network Analysis Techniques of PERT / CPM – Taxation – Income Tax, Excise Duty – Sales Tax.

### UNIT V

**Support to Entrepreneurs** Sickness in small Business – Concept, Magnitude, Causes and Consequences, Corrective Measures – Government Policy for Small Scale Enterprises – Growth Strategies in small industry – Expansion, Diversification, Joint Venture, Merger and Sub Contracting

### TEXT BOOKS:

1. S.S. Khanka, "Entrepreneurial Development" S. Chand & Co. Ltd., 2020.
2. Kuratko & Hodgetts, "Entrepreneurship – Theory, process and practice", Thomson learning 6th edition.

**REFERENCE BOOKS:**

1. Hisrich R D, Peters M P, Dean Shepherd, "Entrepreneurship" 12th Edition McGraw-Hill.
2. Mathew J Manimala," Entrepreneurship theory at cross roads: paradigms and praxis" Dream tech, 2nd edition 2006.
3. Rabindra N. Kanungo, "Entrepreneurship and innovation: Models for Development", Sage Publications, 1998.
4. EDII "Faulty and External Experts — A Hand Book for New Entrepreneurs Publishers:Entrepreneurship Development", Institute of India.

## 22ME832-OE: ELEMENTS OF ELECTRIC AND HYBRID VEHICLES (OPEN ELECTIVE – III)

B.Tech. IV Year, II Sem.

L	T	P	C
3	0	0	3

### Course Objectives

- Explain the history of Electric vehicles and development
- Discuss the Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies
- Explore to basic concept of electric traction, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives etc.
- Analyse the Fuel Cell based energy storage and Super Capacitor based energy storage etc.
- Explore to types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others) etc.

**Course Outcomes:** At the end of the course student will be able to

- Choose the appropriate source of energy for the hybrid electric vehicle based on driving cycle.
- Analyze the power and energy need of the various hybrid electric vehicle and Measure and Estimate the energy consumption of the Hybrid Vehicles
- Evaluate energy efficiency of the vehicle for its drive trains
- Elaborate the types of storage systems such as battery based, fuel cell based etc.
- Explain the types of Driving Cycles, Fuel Cell EV, Solar Powered Vehicles

### UNIT- I:

**Introduction to Electric Vehicle:** History of Electric Vehicles, Development towards 21st Century, Types of Electric Vehicles in use today — Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Motion and Dynamic Equations of the Electric Vehicles: various forces acting on the Vehicle in static and dynamic conditions.

### UNIT- II:

**Introduction to Hybrid and Electric Vehicles:** Social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. Hybrid Electric Drive-trains: Basic concept of hybrid traction, introduction to various hybrid Drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis

### UNIT- III:

**Introduction to Electric Drive Trains:** Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. Electric Propulsion unit: Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency

### UNIT- IV:

**Types of Storage Systems:** Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Calculation for the rating.

### UNIT- V:

**Modelling of Hybrid Electric Vehicle Range:** Driving Cycles, Types of Driving Cycles, Range modelling for Battery Electric Vehicle, Hybrid (ICE & others), Fuel Cell EV, Solar Powered Vehicles. Case study of 2-wheeler, 3 wheeler and 4 wheeler vehicles.

**TEXT BOOKS**

1. James Larminie, J. Lowry, "Electric Vehicle Technology Explained", John Wiley & Sons Ltd. 2003.
2. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles: Fundamentals, Theory, and Design", CRC Press, 2004.

**REFERENCE BOOKS**

1. S. Onori, L. Serrao and G. Rizzoni, "Hybrid Electric Vehicles: Energy Management Strategies", Springer, 2016.
2. Iqbal Hussein, "Electric and Hybrid Vehicles: Design Fundamentals", CRC Press, 2010.