NAGARJUNA

COLLEGE OF ENGINEERING & TECHNOLOGY

An Autonomous College under VTU

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

To train the students as professionals in Mechanical Engineering blended
with leadership qualities to achieve excellence in the challenging future.

MISSION

M1: Maintaining excellence in Mechanical Engineering education through academic professionalism and teaching for the changing needs of the society.

M2: Establishing Centre of excellence for research to promote industrial exposure in the area of Mechanical Engineering.

M3: Developing communication skill, leadership qualities, team work and skills for continuing education among the students

M4: Inculcating ethics, human values and skills for solving societal problems and environmental protection

M5: Creating opportunities to the students for experiencing real time problems through project works to enhance employability and entrepreneurship.

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III & VIII Semesters

Scheme and Syllabus

WitheffectfromAcademicYear 2018-19

Third Semester B.E. - Scheme

Sl. No.	Course Code	Course	Teaching Dept.	L-T-P-S (Hrs/week)	Total Credits	Marks
1	18MEM31	Engineering Mathematics -III	Mathematics	3-0-2-0	4	100
2	18MET32	Measurements and Manufacturing Process	ME	3-0-0-0	3	100
3	18MET33	Basic Thermodynamics	ME	4-0-0-0	4	100
4	18MEI34	Mechanics of Materials (IC)	ME	3-0-2-0	4	100
5	18MET35	Computer Aided Machine Drawing	ME	1-0-4-0	3	100
6	18MET36X	Foundation Elective-I	ME	3-0-0-0	3	100
7	18MEL37	Manufacturing Process Laboratory	ME	1-0-2-0	2	100
8	18MEL38	Mechanical Measurements and Metrology Laboratory	ME	1-0-2-0	2	100
9	18MEH39	Integrated Rural Development – Part 1	ME	0-2-0-0	1	100
Total				**19-2-12-0**	**26**	**900**

Foundation Elective-I

Sl. No.	Courses Code	Course
1	18MET361	Automobile Engineering-I
2	18MET362	Engineering Metallurgy
3	18MET363	Industrial Pollution Control

Fourth Semester B.E. - Scheme

Sl. No.	Subject Code	Course	Teaching Dept.	L-T-P-S (Hrs/week)	Total Credits	Marks
1	18MEM41	Engineering Mathematics- IV (IC)	Mathematics	3-0-2-0	4	100
2	18MET42	Manufacturing Technology	ME	3-0-0-0	3	100
3	18MEI43	Applied Thermodynamics (IC)	ME	3-0-2-0	4	100
4	18MET44	Kinematics of Machines	ME	4-0-0-0	4	100
5	18MET45X	Foundation Elective-II	ME	3-0-0-0	3	100
6	18MET46X	Engineering Elective-I	ME	3-0-0-0	3	100
7	18MEL47	Machine Shop Laboratory	ME	1-0-2-0	2	100
8	18MEL48	Material Testing Laboratory	ME	1-0-2-0	2	100
9	18MEH49	Integrated Rural Development – Part 2	ME	0-2-0-0	1	100
Total				**21-2-8-0**	**26**	**900**

Foundation Elective-II			**Engineering Elective-I**	
Sl. No.	**Course Code**	**Course**	**Course Code**	**Course**
1	18MET451	Automobile Engineering–II	18MET461	Renewable Energy Resources
2	18MET452	Advanced Material Science	18MET462	Object Oriented Programming using C++
3	18MET453	Air Pollution and Control	18MET463	Management Information System
4			18MET464	Smart Materials

Fifth Semester B.E. - Scheme

Sl. No.	Course Code	Course	Teaching Dept.	L-T-P-S (Hrs/ week)	Total Credits	Marks
1	18MET51	Machine Design-I	ME	3-0-0-0	3	100
2	18MEI52	Dynamics of Machines (IC)	ME	3-0-2-0	4	100
3	18MET53	Artificial Intelligence And Robotics	ME	3-0-0-0	3	100
4	18MEI54	Fluid Mechanics (IC)	ME	3-0-2-0	4	100
5	18MET55X	Foundation Elective-III	ME	3-0-0-0	3	100
6	18MET56X	Engineering Elective-II	ME	3-0-0-0	3	100
7	18MEL57	Energy Conversion Laboratory	ME	1-0-2-0	2	100
8	18MEL58	Robotics Laboratory	ME	1-0-2-0	2	100
9	18MEH59	General Aptitude	ME/ BS&H	2-0-0-0	2	100
Total				**22-0-8-0**	**26**	**900**

Foundation Elective-III

Sl. No.	Course Code	Course
1	18MET551	Composite Material Technology
2	18MET552	Power Plant Engineering
3	18MET553	HVAC-I

Engineering Elective-II

Sl. No.	Course Code	Course
1	18MET561	Metal Forming Process
2	18MET562	Mechatronics
3	18MET563	Economics of Engineering

Sixth Semester B.E. - Scheme

Sl. No	Course Code	Course	Teaching Dept.	L-T-P-S (Hrs/ week)	Total Credits	Marks
1	18MET61	Machine Design-II	ME	3-0-0-0	3	100
2	18MEI62	Computer Integrated Manufacturing (IC)	ME	3-0-2-0	4	100
3	18MEI63	Finite Element Methods (IC)	ME	3-0-2-0	4	100
4	18MET64X	Foundation Elective-VI	ME	3-0-0-0	3	100
5	18MET65X	Engineering Elective-III PBL	ME	3-0-0-0	3	100
6	18HOE66X	Open Elective-I	ME/ BS&H	2-0-0-4	3	100
7	18MEL67	Fluid Machinery Laboratory	ME	1-0-2-0	2	100
8	18MEP68	Mini Project and Seminar	ME	1-0-2-0	2	100
9	18MEH69	Technical Aptitude and Group Discussion	ME/ BS&H	2-0-0-0	2	100
Total				**21-0-8-4**	**26**	**900**

Foundation Elective-VI

Sl. No.	Course Code	Course
1	18MET641	Non-Conventional Machining
2	18MET642	Turbo machines
3	18MET643	HVAC-II

Engineering Elective-III / PBL

Sl. No.	Course Code	Course
1	18MET651	Refrigeration and Air Conditioning
2	18MET652	Operations Research
3	18MET653	Wind Energy Engineering

Open Elective–I

Sl. No.	Course Code	Course
1	18HOE661	Lab View – Level 1
2	18HOE662	Yoga and Meditation
3	18HOE663	Martial Arts
4	18HOE664	Music (Carnatic Vocal / Instrumental)
5	18HOE665	Dance
6	18HOE666	Sports
7	18HOE667	Online Certification Courses from IITs / IISc / SWAYAM / EDX

Seventh Semester B.E. - Scheme

Sl. No.	Course Code	Course	Teaching Dept.	L-T-P-S (Hrs/week)	Total Credits	Marks
1	18MEI71	Mechanical Vibrations (IC)	ME	3-0-2-0	4	100
2	18MET72	Heat and Mass Transfer	ME	3-0-0-0	3	100
3	18MET73X	Foundation Elective-V	ME	3-0-0-0	3	100
4	18MET74X	Engineering Elective-IV	ME	3-0-0-0	3	100
5	18HOE75X	Open Elective-II	ME/BS&H	2-0-0-4	3	100
6	18HOE76X	Open Elective-III	ME/BS&H	2-0-0-4	3	100
7	18MEL77	Computer Aided Modelling and Analysis Laboratory	ME	1-0-2-0	2	100
8	18MEL78	Heat and Mass Transfer Laboratory	ME	1-0-2-0	2	100
9	18MEP79	Project Phase-I and Seminar	ME	1-0-4-0	3	100
Total				**19-0-10-8**	**26**	**900**

Foundation Elective-V

Sl. No.	Subject Code	Course
1	18MET731	Engineering Management& Entrepreneurship
2	18MET732	Hydraulics and Pneumatics
3	18MET733	HVAC-III

Engineering Elective-IV

Sl. No.	Subject Code	Course
1	18MET741	Safety, Security & Building Management Systems
2	18MET742	Foundry Technology
3	18MET743	Biomass Energy Systems

Open Elective-II

Sl. No.	Course Code	Course
1	18HOE751	Tax Management
2	18HOE752	Assessment of Building Energy Performance
3	18HOE753	Natural Disaster Mitigation & Management
4	18HOE754	Online Certification Program – MOOCS/NPTEL/IIT/EDX/ Course Era certification. Equivalent to 36 – 40 hours approved by Department

Open Elective-III

Sl. No.	Course Code	Course
1	18HOE761	Small and Medium Enterprise Management
2	18HOE762	Occupational Safety & Health Administration
3	18HOE763	Animation & Multimedia Engineering
4	18HOE764	Online Certification Program – MOOCS/NPTEL/IIT/ EDX/Course Era certification. Equivalent to 36 – 40 hours approved by Department

Eighth Semester B.E. - Scheme

Sl. No.	Course Code	Course	Teaching Dept.	Total Credits	Marks
1	18MEP81	Project Phase-II	ME	4	100
2	18MEP82	Project Phase-III	ME	4	100
3	18MEP83	Evaluation and Viva-Voce (External)	ME	10	100
Total				**18**	**300**

IC – Integrated Course L – Lecture T-Tutorials
P-Practical **S – Self Study**

Engineering Mathematics-III (IC)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEM31	3:0:2:0	4	CIE:50 SEE:50	3 Hours	BS

Course Objectives:

This course will enable students to :

- Develop the application of mathematical skills in solving the engineering problems using computers.
- Use the partial differential equations in engineering applications.
- Use transforms in the engineering problems.
- Find the approximated solutions to engineering problems numerically.

Syllabus

Module - I

Partial Differential Equations: Formation of PDE –Eliminating the Arbitrary constants and arbitrary functions, solutions of non homogenous PDE by direct integration., Method of separation of variables. Applications to PDE – Derivation of one dimensional of wave equation and solution by separation of variables-with specified boundary conditions. Derivation of one dimensional of Heat equation and solution by separation of variables-with specified boundary conditions. **08 Hours**

Module - II

Fourier Series: Periodic functions, Dirchlet's conditions, Euler's Formulae-Fourier series of periodic functions of period 2l and 2π, Half range Fourier series, Practical harmonic analysis. **08 Hours**

Module - III

Fourier–Transform and Calculus of Variations: Infinite Fourier Transform, Fourier Sine and Cosine Transform. Variation of function and a functional. Extremal of a functional, variational problems, Euler 's equation, Standard Variational problems including Geodesics, minimal surfaces of Revolution, hanging chain and Brachistochrone problems. **08 Hours**

Module - IV

Numerical Methods: Numerical solutions of Algebraic and transcendental equations- Regula Falsi Method and Newton Raphson Method. Finite Differences-Forward, Backward and Central differences, Newton's Forward, Newton's Backward and Sterling's interpolation formulae. Lagrange's Interpolation formula (without proof). Numerical Differentiation using Newton's Forward and Backward formulae. **08 Hours**

Module - V

Introduction to SCILAB and its family, Menus and toolbars, Types of windows and types of files, SCILAB Help system, Basic calculations in SCILAB, Basic variables, Functions-Elementary Mathematical, Builtin and User defined functions. Array operations, Matrix operations, Loops: for and while loops, condition statements- if- then and if-then-else statements, plotting of graphs, working with scripts and files.

08 Hours

List of SCILAB Experiments

Sl. No.	Name of the Experiment
1	SCILAB Environment
2	Basic operations in SCILAB
3	Basic Matrix operations
4	SCILAB programming environment
5	Use of Functions
6	Plotting of 2D and 3D Curves
7	Polynomial Evaluation and Determination of Roots of a Polynomial
8	Statistics Using SCILAB
9	Differentiation and Integration using SCILAB
10	Numerical Methods using SCILAB

Course Outcomes:

On completion of this course, the students are able to :

- Form a partial differential equations and their solutions.
- Expressing the given functions as infinite series of sine and cosine.
- Solve the functional and variation problems.
- Find approximated solutions by numerical methods.
- Use the SCILAB to solve the various types engineering problems.

Text Books:

1. Dr. B.S. Grewal: “Higher Engineering Mathematics”, (Chapters 10, 17, 18, 22, 23,28- 30), Khanna Publishers, New Delhi, 42nd Edition, 2012, ISBN:978817409195 6.
2. N.P. Bali and Dr. Manish Goyal: “A Text Book of Engineering Mathematics”, (Chapters10, 16, 17, 20, 22, 23), Laxmi Publications (P) Ltd., New Delhi, 9th Edition, 2014, ISBN: 9788131808320.
3. SCILAB Group: “Introduction to SCILAB, A Users Guide”.

Reference Books:

1. Erwin Kreyszig: “Advanced Engineering Mathematics”, (Chapters 11, 12, 19), Wiley Pvt. Ltd. India, New Delhi, 9th Edition, 2011, ISBN 13: 9788126531356.
2. B.V. Ramana: “Higher Engineering Mathematics”, (Chapters 17-21, 32), Tata Mc Graw – Hill Publishing company Limited, New Delhi, 2nd Reprint, 2007, ISBN 13: 978-0-07063417-0.
3. S.S. Sastry: “Introductory methods of Numerical analysis”, (Chapters 2, 3, 6), PHI Learning Private, Delhi, 5th Edition, 2013, ISBN 13: 978-81-203-4592-8.
4. Stormy Attaway: “A practical introduction to programming and problem solving”, Elsevier, Boston, 2nd Edition.

E-Resources:

1. http://bookboon.com/en/essential-engineering-mathematics-ebook
2. https://www.free-ebooks.net/ebook/essential-engineering-mathematics
3. https://www.scilab.org/resources/documentation/books
4. https://archive.org/details/AdvancedEngineeringMathematics10thEdition
5. https://mars.uta.edu/mae3183/simulation/introscilab_baudin.pdf

Module -

Measurements and Manufacturing Process

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET32	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the basic concepts of measurements.
- Impart the knowledge of angle, temperature and strain measurements.
- Realize the importance of casting processes, steps involved in casting, moulding sands, patterns, binders and additives.
- Know the principles of sand moulding, cores, gating and risering and moulding machines.
- Study the moulding processes, metallic moulds and furnaces.

Syllabus

Module - I

Standards of measurement: Definition and Objectives of metrology, Standards of length-International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-81, M-112), Numerical problems on building of slip gauges.

Measurement of force and pressure: Principle, analytical balance, platform balance, proving ring, Pressure measurements, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. **08 Hours**

Module - II

Angular measurements: Bevel protractor, sine principle and use of sine bars, sine centre, use of angle gauges (numerical on building of angles), Introduction to screw thread and gear measurement

Temperature and strain measurement: Resistance thermometers, thermocouple, law of thermo couple. Strain measurements, strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. **08 Hours**

Module - III

Introduction: Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process and steps involved. Varieties of components produced by casting process.

Advantages and Limitations of casting process.

Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns, BIS colour coding of Patterns.

Binder: Definition, Types of binder used in moulding sand.

Additives: Need, Types of additives used and their properties. **08 Hours**

Sand Moulding: Types of base sand, requirement of base sand, Moulding sand mixture ingredients for different sand mixtures, Methods used for sand moulding such as Green sand, dry sand and skin dried moulds.

Cores: Definition, Need, Types, Method of making cores, Binders used, core sand moulding.

Concept of Gating and Risers: Principle and types.

Fettling and cleaning of castings: Basic steps, Casting defects, Causes, features and remedies. **08 Hours**

Module - V

Melting Furnace: Cupola construction, zones and operation of conventional Cupola.

Special Moulding Processes : Sweep mould, CO_2 mould, Shell mould, Investment mould.

Metal moulds: Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Thixo-casting and Continuous Casting Processes. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Explain the objectives of measurement, different methods of force and pres- sure measurements.
- Demonstrate the measurements of angle, temperature and strain.
- Identify various types of patterns, binders, additives, cores and moulding ma- chines.
- Analyze working principle of gating and risering systems, special moulding processes.
- Describe different furnaces used for melting of metals and special types of casting process.

Text Books:

1. Beckwith, Marangoni, Leinhard: “Mechanical Measurements”, (Chapters 12- 14,16), Pearson Education, 6th Edition, 2007, ISBN-13: 978-81-317-1718-9.
2. P.N.Rao: “Manufacturing Technology”, Volume-1, (Chapters 3-6), Tata McGraw Hill, 4th Edition, 2013, ISBN-13: 978-12590-62575.
3. P.L.Jain: “Principles of Foundry Technology”, (Chapters 1-8), McGraw Hill Education (India) Private Ltd., 2009, ISBN-13: 978-0-07-015129-1.

Reference Books:

Module -

1. Serope Kalpakjian and Steven R. Schmid, “Manufacturing Engineering and Technology”, (Chapters 11), Pearson Publication, 4th Edition, 2006, ISBN-13: 9788177581706.
2. I.C. Gupta, “Engineering Metrology”, (Chapters 2,4,6), Dhanpat Rai Publications,
   7th Edition, 2012, ISBN-13: 9788189928452 .

Basic Thermodynamics

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET33	4:0:0:0	4	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Learn the fundamentals of thermodynamics and related definitions to under- stand the temperature concept and thermodynamic principles.
- Impart the concept of work and heat and the laws of thermodynamics.
- Develop the ability to analyse the engineering devices and to calculate work done, heat transfer and other properties.
- Understand the principle of entropy and behaviour of pure substances.
- Know the principles of ideal gases and real gases.

Syllabus

Module - I

Fundamental Concepts and Definitions: Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties, definition and units, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes, Thermodynamic equilibrium, mechanical equilibrium, diathermic wall, chemical equilibrium, Zeroth law of thermodynamics, Temperature, concepts, scales, fixed points and measurements, numerical problems.

Work and Heat: Mechanics, definition of work. Thermodynamic definition of work: examples, sign convention. Displacement work, as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work: Electrical work. Heat, definition, units and sign convention, numerical problems. **12 Hours**

Module - II

First Law of Thermodynamics: Joule's experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy. Extension of the First law to control volume, steady state-steady flow energy equation, important applications, analysis of unsteady processes such as film and evacuation of vessels with and without heat transfer,

numerical problems. **10 Hours**

Module - III

Second Law of Thermodynamics: Devices converting heat to work: (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir, Direct heat engine: schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle, reversed heat engine, schematic representation, coefficients of performance. Kelvin - Planck statement of the Second law of Thermodynamics: PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements, Reversible and irreversible processes, factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles, numerical problems. **10 Hours**

Module - IV

Entropy: Clausius inequality: Statement, proof, application to a reversible cycle. Entropy: definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Discussion on available and unavailable energies,

numerical problems. **10 Hours**

Module - V

Pure Substances: Definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. P-T and P-V diagrams, triple point and critical points. Sub cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat), Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use, Throttling calorimeter, separating and throttling calorimeter, numerical problems. Brief introduction to ideal gases and real gases, Introduction to Vander Waal's Equation of state, Vander Waal's constants in terms of critical properties. **10 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Demonstrate the use of zeroth law of thermodynamics in temperature measurements and also the work and heat transfer in a Thermodynamic systems.
- Formulate the heat, work and energy of the system for various Thermodynamic processes.

- Evaluate the performance of heat engines and heat pumps/refrigerators.
- Analyze the Entropy change for various thermodynamic processes.
- Describe the Thermodynamic properties of pure substances and to distinguish between ideal and real gases.

Text Books:

1. P.K.Nag :"Basic and Applied Thermodynamics", (Chapters 1-7,9,10), Tata McGraw Hill Publications, 2nd Edition, 2002, ISBN-13: 978-0070151314.
2. Yunus A.Cenegal and Michael A.Boles: "Thermodynamics, An Engineering Approach", (Chapters 1-8), Tata McGraw Hill Publication, 2002, ISBN 13: 9780070495036.

Data Hand Books:

1. B T Nijaguna, B S Samaga: "Thermodynamic Data Hand Book", Sudha Publications, ISBN-13: 1234567147821.
2. R.Niranjan Murthy: "Thermodynamic Data Hand Book", Published by Sapna book house, ISBN-13: 9788128000041.

Reference Books:

1. A.Venkatesh: "Basic Engineering Thermodynamics", (Chapters 1-5,8-11), Univer- sities Press, 2008, ISBN-13: 978-8173715877.
2. J.B.Jones and G.A.Hawkins: "Engineering Thermodynamics", (Chapters 1-9), John Wiley and Sons, ISBN 13: 9780471812029.
3. B.K Venkanna, Swati B. Vadavadagi: "Basic Thermodynamics", (Chapters 1-7), PHI, New Delhi, 2010, ISBN-13: 978-8120341128..

Mechanics of Materials (IC)

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEI34	3:0:2:0	4	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the characteristics of the ferrous, nonferrous metals and alloys.
- Study the phenomena of fracture, creep and fatigue.
- Impart the knowledge of fundamental concepts regarding the behaviour of deformable bodies under influence of external loading.
- Enlighten the students with concept of shear force and bending moment diagrams.
- Develop an ability to analyze the thin and thick cylinders and the behaviour of circular shafts under torsional loads.

Syllabus

Module - I

Ferrous and non ferrous materials: Properties, Composition and uses of Grey cast iron, malleable iron, SG iron and steel, Copper alloys-brasses and bronzes, Aluminium alloys-Al-Cu, Al-Si, Al-Zn alloys, stress-strain diagram for ductile and non-ferrous materials. **07 Hours**

Module - II

Fracture: Type I, Type II and Type III.

Creep: Three stages of creep, creep properties, stress relaxation.

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram. **07 Hours**

Module - III

Simple Stress and Strain: Introduction, stress, strain, types of stress and strain, Elasticity, Plasticity, mechanical properties, Hooke's law, Poisson's ratio, Extension / Shortening of a bar, bars with cross sections varying in steps, principle of Superposition. Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses in simple bars, elastic constants, relation between elastic constants (without proof), numerical problems. **09 Hours**

Module - IV

Shear Force and Bending Moment: Introduction, Types of beams, loads, shear forces and bending moments, sign conventions, Shear force and bending moment diagrams for cantilever, simply supported beams subjected to point load and uniformly distributed load (UDL) and uniformly varying load (UVL) and couple. Relation between shear force and bending moment, numerical problems. **08 Hours**

Module - V

Torsion of Circular Shafts: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts, numerical problems.

Thick and Thin Cylinders: Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume), Thick cylinders, Thick cylinders subjected to internal and external pressures (Lame's equation), numerical problems. **09 Hours**

List of Experiments

1. Identification of microstructure of ferrous material.
2. Identification of microstructure of non- ferrous material.
3. To determine young's modulus of mild steel under tensile loading.
4. To determine Poisson's ratio of mild steel.
5. To find the bending stress of cantilever beam.
6. To find the bending stress of simply supported beam.
7. To determine the stress in cylinder.

Course Outcomes:

On completion of this course, the students are able to :

- Describe the properties and composition of various materials.
- Identify the different types of fracture and fatigue, behaviour of material under creep.
- Determine stress, strain and deformation in members subjected to various loads.
- Gain insight into the concepts of shear force and bending moment and can draw shear force and bending moment diagram for beams subjected to different loads.
- Differentiate thick and thin cylinders and carryout analysis of torsional

shafts.

Text Books:

1. S.S.Bhavikatti: “Strength of Materials”, (Chapters 2,3,6,8), Vikas publications House Private Limited, 3rd Edition, 2008, ISBN-13: 9788125927914.
2. S Ramamrutham: “Strength of Materials”, (Chapters 1,2,5), Dhanpat Rai Publica- tion, 14th Edition, 2004, ISBN-13: 978-8187433545.
3. William D. Callister, “Materials Science and Engineering –An Introduction”, (Chapters 8,11), John Wiley and Sons, 6th Edition, 2006, ISBN: 81-265-0813-2.

Reference Books:

1. George E Dieter: “Mechanical Metallurgy”, (Chapters 7,12,13), McGraw Hill Pub- lication, 3rd Edition, 1986, ISBN: 0-07-100406-8.
2. R.C.Hibbeler: “Mechanics of Materials”, (Chapters 1-6), Pearson Education, 9th Edition, 2013, ISBN: 978-81-317-1502-4.
3. James.M.Gere, Barry J. Goodno: “Mechanics of Materials”, (Chapters 1-4,8), Thomson Publication, 6th Edition, 2007, ISBN: 978-81-315-0366-9.
4. Egor P Popov, Toader A.Balan: “Engineering Mechanics of Solids”, (Chapters 1-6), Pearson Education, 2nd Edition, 2008, ISBN: 978-81-7758-578-0..

Computer Aided Machine Drawing

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET35	1:0:4:0	3	CIE:50 SEE:50	3 Hours	F C

Course Objectives:

This course will enable students to :

- Train students to draw the orthographic projections of various machine parts.
- Make the students know about various threads and fasteners.
- Understand different keys and joints used in mechanical assembly and types of riveted joints.
- Know about the different couplings used in assembly of shafts.
- Make the students learn about part modeling, assembly and detailed drawing of the various machine parts.

Syllabus

Module - I

Orthographic Views: Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.

06 Hours

Module - II

Thread Forms: Thread terminology, Sectional views of threads. ISO Metric (Internal and External) BSW (Internal and External) square and Acme. Sellers thread, American Standard thread.

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. **07 Hours**

Module - III

Keys : Parallel key, Taper key, Feather key, Gibhead key and Woodruff key.

Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). **07 Hours**

Module - IV

Couplings: Split Muff coupling, Protected type flanged coupling and pin (bush) type flexible coupling. **06 Hours**

Module - V

Assembly Drawings (Part drawings should be given)

1. Plummer Block (Pedestal Bearing)
2. Screw Jack (Bottle type)
3. Machine Vice
4. Universal Joint
5. Knuckle Joint **14 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Draw the orthographic projections of various machine parts.
- Create use, identify and explain various threads and fasteners.
- Identify and explain different keys and joints used in mechanical assembly and types of riveted joints.
- Draw different couplings used in assembly of shafts.
- Use standard software tools to create engineering drawings or other documents to fully describe the geometries and dimensions of parts, as well as to document on part modeling, assembly and detailed drawing of the various machine parts.

Text Books:

1. N.D.Bhatt: “Machine Drawing”, (Chapters 4-9,12,13,19), 45th Edition, Charotar Publishers, 2008, ISBN: 81-85594-38-4.
2. K.R.Gopalkrishna: “Machine Drawing”, (Chapters 1-9), 22nd Edition, Subha Publication, 2013.

Reference Book:

1. S. Trymbaka Murthy: “A Text Book of Computer Aided Machine Drawing”, CBS Publishers and Distributors Pvt. Ltd., 2008, ISBN-13: 9788123916590.

Conducting classes : Classes may be conducted in two slots per week, of 3

Hours each (Instruction 1 hr. + Sketching and Practice 2 hr.)

Scheme of Evaluation:

Continuous Internal Evaluation (CIE)

CIE - 1	- 30 marks
CIE – 2	- 30 marks
Surprise test	- 10 marks
Submission of sketch Book	- 30 marks
Total	**- 100 marks**

Semester End Examination (SEE)

Part A – Module 1 or Module 2	- 20 marks
Part B – Module 3 or Module 4	- 20 marks
Part C - Module 5	- 60 marks
Total	**- 100 marks**

Note: One question to be set from Module 1,2,3 and 4 each. Two Questions are to be
set from Module 5. Students have to answer any one question from each part.

Automobile Engineering–I

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET361	3:0:0:0	3	CIE:50 SEE:50	3 Hours	F E

Course Objectives:

This course will enable students to :

- Understand IC engine, its components and different types of fuels.
- Develop skills in fuel supply systems for SI and CI engines.
- Understand the principle of superchargers and turbochargers.
- Impart the knowledge of ignition system.
- Know basic concept of automotive chassis.

Syllabus

Module - I

IC Engine Components: SI and CI engines, cylinder – arrangements and their relatives merits, Liners, Piston, connecting rod, crankshaft, valves, valve actuating mechanisms, valve and port timing diagrams, Compression ratio, choice of materials for different engine components, engine positioning, cooling requirements, methods of cooling, different lubrication arrangements. **08 Hours**

Module - II

Fuels, Fuel Supply Systems for SI And CI Engines: Conventional fuels, alternative fuels, normal and abnormal combustion, cetane and octane numbers, Fuel mixture requirements for SI engines, types of carburetors, C.D.and C.C. carburetors, multi point and single point fuel injection systems, fuel transfer pumps, fuel filters, fuel injection pumps and injectors. **08 Hours**

Module - III

Superchargers And Turbochargers: Naturally aspirated engines, Forced induction, Types of superchargers, Turbocharger construction and operation, Intercooler, Turbocharger lag. **08 Hours**

Module - IV

Ignition Systems: Battery Ignition systems, magneto Ignition system, Transistor assist contacts. Electronic Ignition, Automatic Ignition advance systems. **08 Hours**

Module - V

Automotive Chassis: Types of chassis layout with reference to power plant locations and drive, Vehicle frames. Various types of frames. Constructional details, Materials. Testing of vehicle frames. Unitized frame body construction: Loads acting on vehicle frame. **08 Hours**

Course Outcomes:

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

- Describe IC engine, its components.
- Analyze the selection of fuels.
- Demonstrate the concept of supercharger and turbocharger.
- Get exposed to knowledge of ignition system.
- Design the automotive chassis.

Text Books:

1. William H Crouse and Donald L Anglin: “Automotive mechanics”, (Chapters 12,13,16-19,31,32,49-51), Tata McGraw Hill Publishing Company Ltd., 10th Edition, 2006, ISBN-13: 9780070634350.
2. Kirpal Singh: “Automobile engineering”, (Chapters 4,7,8,22), Vol 1 and 2, Standard Publishers, 12th Edition, 2011, ISBN-13: 9788180141713.

Reference Books:

1. R. B. Gupta: “Automobile Engineering”, (Chapters 3,8,9,11,17,18,20,30) Satya Prakashan publisher, 4th Edition, 2015, ISBN-13: 9788176843799
2. S. Srinivasan: “Automotive Mechanics”, (Chapters 9,12-14,17,28), McGraw Hill Education (India) Private Limited, 2nd Edition, 2003, ISBN-13: 978- 0070494916.

Module -

Engineering Metallurgy

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET362	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Introduce students to the fundamentals of structure-property correlation by familiarizing them with crystalline materials, their properties and their defects.
- Give an introduction to the studies of solidification, solid solutions and phase diagrams. To solve problems in phase-diagrams.
- Understand the importance of Fe-C equilibrium diagram and the TTT diagrams and the difference between them.
- Get an introduction to the various heat treatment processes.
- Gain the knowledge of testing of materials.

Syllabus

Module - I

Crystal Structure: BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections, Atomic Diffusion: Phenomenon, Ficks laws of diffusion, factors affecting diffusion, simple problems. **08 Hours**

Module - II

Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures. Phase Diagram I: Solid solutions Hume Rothary rule, substitutional and interstitial solid solutions, intermediate phases, Gibbs phase rule. **08 Hours**

Module - III

Phase Diagram-II: Construction of equilibrium diagrams involving complete and partial solubility, lever rule, Iron carbon equilibrium diagram, description of phases, solidification of steels and cast irons, invariant reactions. **08 Hours**

Module - IV

Heat treating of metals: TTT curves, continuous cooling curves,

annealing and its types. normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys.

08 Hours

Testing of materials : Need of testing, Destructive and non destructive testing, Mechanical testing, Tensile test, Impact test, Izod and Charpy test, Hardness measurement, Rockwell , Brinell hardness, micro hardness. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Explain the structure of material and atomic diffusion.
- Describe the mechanism of solidification and types of phase diagrams.
- Identify different types of phases, invariant reactions in iron-carbide phase diagram.
- Analyze various heat treatment processes.
- Demonstrate the working principles of different testing methods for materials.

Text Books:

1. William D. Callister: “Materials Science and Engineering-an introduction”, (Chapters 3,5,6,10,11), John Wiley and Sons, 4thEdition, 2012, ISBN: 1118061608.
2. James F.Shackelford, M K Muralidahar: “Introduction to Materials Science for Engineers ”, (Chapters 3-5,9,10), Pearson Publication, 6thEdition, 2007, ISBN: 978-81-317-0090-7.
3. V Raghavan: “Physical Metallurgy”,(Chapters 1-4), PHI, New Delhi ,2nd Edition, 2006, ISBN 13: 9788120330122.

Reference Books:

1. Alan Cottrell, “An Introduction to Metallurgy”, (Chapters 12,13,15,20), Universities Press, 2nd Edition, 1990, ISBN: 8173712395.
2. T.V.Rajan and C.P. Sharma, Ashok Sharma, “Heat Treatment: Principles and Techniques”, (Chapters 2-5,8,9) Prentice Hall of India, New Delhi, 2nd Edition 2007, ISBN 13: 9788120307162.

Industrial Pollution Control

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET363	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Understand types of pollutions and their sources, sampling and analyzing pollutants in water.
- Know design methods of treatment of industrial waste water with respect
  few industrial wastes.
- Study sources of air pollution, air sampling and prevention.
- Gain knowledge of sources of solid wastes treatment and processing methods.
- Methods of determination of noise levels and safety methods.

Syllabus

Module - I

Introduction: Importance of environment for mankind. Biosphere and layers of atmosphere. Hydrological cycle and nutrient cycles. Types of pollution. Damages from environmental pollution. Need of environmental legislations and environmental Acts in India. Functions of central and state pollution control boards. Global warming, Kyoto protocol, Role of environmental groups like Green Peace.

Sources, sampling and analysis of waste water: Water resources. Origin of waste water. Evaluation, classification and characterization of waste water. Physical and chemical characteristics. BOD, COD and their importance. Types of water pollutants and their effects. Sampling, and methods of analysis. **08 Hours**

Module - II

Waste water treatment: Preliminary, primary, secondary and tertiary treatments of waste water. Sludge treatment and disposal. Modern treatment methods. Recovery of materials from process effluents.

Applications to Industries: Norms and standards of treated water. Origin, characters, and treatment methods of typical industries – petroleum refinery, pulp and paper, fertilizer, distillery, and textile processing. **08 Hours**

Module - III

Air pollution aspects: Nature of air pollution. Classification of air pollutants. Sources of air pollutants. Air quality criteria and standards. Plume behaviour and dispersion of air pollutants. Effects of air pollution on health, vegetation, and materials.

Air pollution treatment: Sampling of pollutants. Methods of estimation of air pollutants. Automobile pollution. Control methods for particulates and gaseous pollutants. Pollution from chemical industries. Origin, control methods, and equipment used in typical industries – Thermal power plants, metallurgical industries,

and cement industries. Carbon credits. **08 Hours**

Module - IV

Solid waste treatment: Origin, Classification and microbiology. Properties and their variation. Engineered systems for solid waste management – generation, onsite handling, storage, collection, transfer and transport, composting, sanitary land filling. **08 Hours**

Module - V

Noise control: Sources and definitions. Determination of noise levels. Noise control criteria and noise exposure index. Administrative and engineering controls. Acoustic absorptive materials.

Safety: Introduction to Process Safety- Intrinsic and Extrinsic Safety. The Hazards- Toxicity, Flammability, Fire, Explosions. Sources of ignition, Pressure.

Safety devices: Pressure relief valves. Ruptures discs. Blow down systems. Flare systems. Flame arrestors. Deflagration arrestors and explosion suppression. Personal safety devices. **08 Hours**

Course Outcomes :

On completion of this course, the students are able to :

- Explain the types of pollutions and their sources and analyze effects

of pollutants in water.

- Design waste water treatment plants depending on the type of industrial
  waste waters.
- Identify the sources of air pollution by carrying out air sample analysis and suggest schemes for its prevention.
- Suggest schemes for processing municipal and industrial solid-wastes.
- Determine noise levels and judge suitable technique for abatement of noise levels. Explain industrial process safety needs based on the history and operation methods of a process industry.

Text Books:

1. C.S.Rao: "Environmental Pollution Control Engineering", (Chapters 1-11), New Age International, Reprint, 2006, ISBN-13: 978-9351343479.
2. Mahajan S.P: "Pollution Control in Process Industries", (Chapters 1-3), Tata Mc- Graw Hill, 1987, ISBN-13: 978-0074517727.

Reference Books:

1. Perkins H.C: "Air Pollution", (Chapters 1-8), McGraw Hill, 1974, ISBN 13: 978- 0070493025.
2. Metcalf and Eddy: "Waste Water Engineering, Treatment, Disposal and Reuse", (Chapters 1-7), Tata McGraw Hill, 4th Edition, 2007, ISBN-13: 9780070416772.

Manufacturing Process Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEL37	1:0:2:0	2	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the testing of moulding sand.
- Prepare the moulds using cope and drag boxes with patterns or without pat-tern.
- Learn the design of gating system.

Syllabus

PART-A

1. Testing of Moulding sand

i. Compression, Shear and Tensile tests on Universal Sand Testing Machine.

ii. Permeability Test.

iii. Core and Mould Hardness Test.

iv. Grain Fineness Number Test (Sieve Analysis Test). Clay Content test.

2. Metal joining process using welding

i. Preparation of welding models (lap joint, butt joint, T-joint).

PART-B

Foundry1. Practice:

Preparation of Moulds using Two Moulding Boxes using Patterns or without patterns (Split pattern, Match plate Pattern and Core Boxes) and design of gating system.

PART-C

Demonstration of 3D Printing

Course Outcomes:

On completion of this course, the students are able to :

- Conduct tests on foundry sands to determine properties for different ingredi- ent compositions.
- Apply knowledge of design and practices of mould and pattern making.
- Analyze the design of gating system.

Scheme of Examination:

One question is to be set from Part-A : 15 Marks

One question is to be set from Part-B : 25 Marks

Viva-Voce : 10 Marks

Total	**: 50 Marks**

Mechanical Measurements and Metrology Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEL38	1:0:2:0	2	CIE:50 SEE:50	3 Hours	F C

Course Objectives:

This course will enable students to :

- The importance/need of mechanical measurements and metrology in day to day practical life.
- Know the different measurement systems and the errors associated with them.
- Importance of calibration of measurement instruments.
- Study the various sensors, transducers and strain gauges employed in measurement systems.
- Learn Linear, angular measurement and threaded parameters.

Syllabus

List of Experiments:

1. Calibration of Pressure Gauge.
2. Calibration of Thermocouple.
3. Calibration of LVDT.
4. Calibration of Load cell.
5. Calibration of micrometer using slip gauges.
6. Determination of modulus of elasticity of a mild steel specimen using strain gauges.
7. Measurements using Tool makers microscope.
8. Measurement of angles using sine center/sine bar.
9. Measurement of angles using bevel protractor.
10. Determination of screw thread parameters using Two-wire and Three-wire method.
11. Determination of gear tooth profile using gear tooth vernier.
12. Measurements using optical projector.

Course Outcomes:

On completion of this course, the students are able to :

1. Calibrate various measuring device, equipments in manufacturing industries.
2. Work with various measuring equipments applied to engineering analysis in industries.
3. Maintain the Quality control principles applicable to all engineering products.
4. Measure Temperature, Pressure and Strain using different methods.
5. Recognize screw thread and gear tooth profile parameters.

Scheme of Examination:

Students has to conduct any two Experiments, each Experiment carries 20 Marks.

Total	:	40 Marks
Viva –Voce	:	10 Marks
Total	**:**	**50 Marks**

Integrated Rural Development – Part 1

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEH39	0:2:0: 0	1	CIE:50 SEE:50	2 Hours	HSS

Course Objectives:

This course will enable students to:

- Gain an awareness of the existing challenges in rural areas of India
- Develop the ability to communicate and interact with rural sections of our society
- Use and apply their academic knowledge to facilitate rural development and uplift via targeted initiatives and activities.

Syllabus

Module - I

Introduction: Introduction to the course and its objectives; overview of typical challenges faced in villages; importance of integrating villages in mainstream society; relevance of course to nation building; division of students into groups; allotment of villages to student groups; assignment of mentors to student groups. **03 Hours**

Module - II

Project Definition: Visit of student groups to respective villages with assigned mentors; interacting with villagers and ice-breaking activities; identifying possible project topics with the help of mentor and supervisor; student group discussion to finalize the project definition; review of project definition with mentor and supervisor. **06 Hours**

Module - III

Project Conceptualization and Planning: Creation of plan to realize the project; review of plan with mentor and supervisor; assigning action items to students within the group; planning for needed logistics and infrastructure. **06 Hours**

Module - IV

Project Realization: Execution of the project plan (for example by conducting workshops); aggregation of project deliverables like survey reports, collected data, interviews, and questionnaires; recording of impact of

the project on the village; periodical review of the project execution status as well as the project deliverables (like aggregated data and survey reports) with mentor and supervisor. **10 Hours**

Module - V

Project Reporting: Creation of project report by the student groups detailing the motivation for the project, the approach, the work packages along with student assignments, the execution of the project, impact of the project, and lessons learned by the students during the project; creation of a slide-set to present the project report during the final exam; review by mentor and supervisor. **03 Hours**

Course Outcomes:

On completion of this course, students will be able to:

- Develop the ability to interact and communicate with different sections of society, thus improving their communication skills.
- Understand the existing problems and needs of a village, thus developing an awareness of the challenges facing rural India.
- Conceptualize, plan, and realize measures to address these problems, thus improving their practical problem-solving and leadership skills.
- Make an impact to rural section of society, thus building their self-confidence.

Text Books:

1. Bhagawan Sri Sathya Sai Baba: “Service to Village is Service to God”, Sri Sathya Sai Publications.

Reference Books:

1. Bhagawan Sri Sathya Sai Baba: “Man Management: A Value-Based Management Perspective”, Sri Sathya Sai Publications.
2. Lt. Gen. M.L.Chibber:“Sai Baba’s Mahavakya on Leadership : Book for Youth, Parents and Teachers.”

E-Resources:

1. http://rural.nic.in/netrural/rural/index.aspx
2. www.annapoorna.org.in

Engineering Mathematics-IV (IC)

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEM41	3:0:2:0	4	CIE:50 SEE:50	3 Hours	B S

Course Objectives:

This course will enable students to :

- Develop the application of mathematical skills in solving statistics and probability problems using computers.
- Find differentiation, integration and solutions of differential equations using numerical methods.
- Analyze of complex variable functions, Introduction of Statistical Software's.

Syllabus

Module - I

Numerical Methods-I: Numerical Integration-Trapezoidal rule, Simpson's 1/3rd and 3/8th rule. Numerical solutions of ordinary differential equations of first order and first degree- Picard's method, Taylor's Series method, Modified Euler's Method, Runge-Kutta Method of 4th order and Milne's Predictor Corrector Method. **08 Hours**

Module - II

Numerical Methods-II: Numerical solutions of simultaneous first order ordinary differential equations: Picard's method and Runge- Kutta method of fourth order. Numerical solutions of second order ordinary differential equations: Picard's method and Runge-Kutta method of fourth order. Numerical solutions of partial differential equations:-One dimensional heat equation. one dimensional wave equation**.**

08 Hours

Module - III

Complex variables: Functions of a complex variable, derivative of complex functions. Analytic functions: Cauchy's-Riemann equations in Cartesian and polar forms (No problems by using limits), Harmonic functions, construction of analytic functions by using Milne-Thomson method. Cauchy Theorem, Cauchy's integral formula- problems. **08 Hours**

Module - IV

Probability and statistics: Probability distributions: Poisson distribution, Poisson distribution is the limiting case of binomial distribution. Constants of Poisson distribution (no proof), Continuous random variable, Continuous probability distribution, Normal distribution (no proof)-problems.

Sampling and inference: Sampling distribution, testing of hypothesis, level of significance, confidence limits. Test of significance of large samples, sampling of variables, central limit theorem, confidence limits for unknown means, students t-distribution. **08 Hours**

Module - V

Introduction to R, Basic Data types, vector operations, matrix construction, lists, data frames, Elementary statistics with R-Qualitative and Quantitative data, Numerical measures, probability distribution, interval estimation and simple linear regression.

08 Hours

List of R-Lab Experiments	
Sl. No.	**Name of the Experiment**
1	Introduction to R Software and basic commands
2	Demonstration and operations of Vectors
3	Operations of Matrices
4	Demonstration of Lists
5	Demonstration of Data Frames
6	Qualitative Data Analysis
7	Quantitative Data Analysis
8	Numerical Measures of Data
9	Probability Distribution
10	Linear Regressions

Course Outcomes:

On completion of this course, the students are able to :

- Determine the Differentiation, Integration using numerical methods.
- Solve Differential equations using numerical methods.
- Find the differentiation and integrals of complex functions.

- Find the probability using different distributions and analysis by using samplings.
- Use the statistical software's.

Text Books:

1. Dr. B.S. Grewal: "Higher Engineering Mathematics", (Chapters 20,26,27,30,32, 33), Khanna Publishers, New Delhi, 42nd Edition, 2012, ISBN: 9788174091956.
2. N.P. Bali and Dr. Manish Goyal, "A Text Book of Engineering Mathematics", (Chapters : 19,21,22,24,25), Laxmi Publications (P) Ltd., New Delhi, 9th Edition, 2014, ISBN: 9788131808320.
3. W.N.Venables, D.M.Smith : "An introduction to R".

Reference Books:

1. Erwin Kreyszig: "Advanced Engineering Mathematics", (Chapters 13, 14,19,21,24,25), Wiley Pvt. Ltd., India, New Delhi, 9th Edition, 2011, ISBN 13: 9788126531356.
2. B.V. Ramana: "Higher Engineering Mathematics", (Chapters 22,23,27-29,32,33), Tata McGraw – Hill Publishing Company Limited, New Delhi, 2nd Reprint, 2007, ISBN 13: 978-0-07063417-0.
3. S.S.Sastry: "Introductory methods of numerical analysis", (Chapters 6,8,9), PHI Learning Private Ltd., Delhi, 5th Edition, 2013, ISBN: 978-81-203-4592-8.
4. John Verzani: "Using R for introductory Statistics", Champan and Hall/ CRC, New York, Washington D.C., ISBN: 978-1-59327-384-2.

E-Resources:

1. http://www.zums.ac.ir/ebooks/mathematics/essential-engineering-mathemat-
   ic.
2. https://archive.org/details/AdvancedEngineeringMathematics10thEdition
3. https://www.**r**-project.org/

Manufacturing Technology

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET42	3:0:0:0	3	CIE:50 SEE:50	3 Hours	F C

Course Objectives:

This course will enable students to :

- Understand fundamentals of metal cutting.
- Impart the knowledge of cutting tool materials and lathe operations.
- Understand the drilling machines, shaping and planning machines.
- Gain the knowledge of milling operations and indexing mechanism.
- Know the Grinding machines, CNC lathe andmilling machine.

Syllabus

Module - I

Theory of metal cutting: Single point cutting tool nomenclature, geometry, orthogonal and oblique cutting, mechanism of chip formation, types of chips, Merchant's analysis, shear angle relationship, tool wear, tool failure, effect of cutting parameters, tool life criteria, Taylor's tool life equation, numerical problems on tool life equation.

Machinability: Factors affecting machinability, heat generation in metal cutting, factors affecting heat generation, measurement of tool tip temperature. **09 Hours**

Module - II

Cutting tool materials: Desired properties, types of cutting tool materials- HSS, carbides, coated carbides, and ceramics, cutting fluids, desired properties, types and selection.

Production Lathes: Capstan and turret lathes- construction features, tool and work holding devices, tool layout. Driving mechanisms of lathe, Different operations on lathe. **08 Hours**

Module - III

Drilling and its related operations: Types of drills, drill bit nomenclature, machining time, Numerical problems, Boring: Boring machine, types, Reaming, trepanning.

Shaping and planning machine: Classification, construction features, driving mechanisms, shaping and planning operations, tool and work holding devices.

09 Hours

Module - IV

Milling Machines: Classification, constructional features, milling cutters, Nomenclatures, milling operations, indexing: simple, compound, differential and angular indexing, calculations and problems on simple and compound indexing.

08 Hours

Grinding machines: Types of abrasives, bonding process, classification, Constructional features, surface designation and selection of grinding wheel, dressing and truing of grinding wheel. Introduction to NC, CNC lathe(Basic function, type of programming, advantages and disadvantages). **08 Hours**

Course Outcomes :

On completion of this course, the students are able to :

- Describe the fundamentals of metal cutting.
- Use different cutting tools and lathe operations.
- Analyze the operations of milling, drilling grinding machines.
- Manage CNC lathe and milling machine.
- Operate the lathe, milling and shaping machines.

Text Books:

1. Hazara Choudhry: "Workshop Technology Vol-II", (Chapters 2-13), Media Promoters and Publishers Pvt. Ltd., 2nd Edition, 2010, ISBN: 81-85099-15-4.
2. R.K.Jain: "Production Technology", (Chapters 10-18,20,22-24,26,32), Khanna Publications, 17th Edition, 2014, ISBN: 81-7409-099-1.

Reference Books:

1. Amitabha Ghosh and Mallik: "Manufacturing Science", (Chapter 4), Affiliated East West Press, 2nd Edition, 2010, ISBN-13: 978-81-7671-063-3.
2. G.Boothroyd: Winston A. Knight, "Fundamentals of Metal Machining and Machine Tools", (Chapters 1-5,10), CRC Press, 3rd Edition, 2005, ISBN 13: 978-1574446593.

E-Resources:

1. http://www.nptel.ac.in/downloads/112105127
2. http://nptel.ac.in/video.php?subjectId=112105126

Applied Thermodynamics (IC)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEI43	3:0:2:0	4	CIE:50 SEE:50	3 Hours	F C

Course Objectives:

This course will enable students to :

- Learn and apply concepts of combustion thermodynamics to various energy conversion processes and systems.
- Implement various aspects of air standard cycles and basic concepts of va-pour power cycles.
- Impart the knowledge of various working aspects of internal combustion engines.
- Study various psychometric processes, understand the working of air conditioning systems and refrigeration systems.
- Gain the knowledge of gas turbines and jet propulsion.

Syllabus

Module - I

Combustion thermodynamics: Theoretical (Stoichiometric) air and excess air for combustion of fuels. Mass balance, actual combustion. Exhaust gas analysis, A/F ratio, Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion, Combustion efficiency, adiabatic flow temperature,

numerical problems. **09 Hours**

Module - II

Air standard cycles: Carnot, Otto, Diesel and Dual cycles, P-V and T-S diagrams, description and efficiencies, concept of mean effective pressure, comparison of Otto, Diesel and Dual combustion cycles, numerical problems. Introduction to Kalina cycle, normal Rankine cycle and Organic Rankine cycle. **09 Hours**

Module - III

Internal Combustion Engines: Testing of two stroke and four stroke SI and

CI engines for performance, Related numerical problems, heat balance, Motoring Method, Willian's line method, Swinging field dynamometer, Morse test, numerical problems. **08 Hours**

Module - IV

Refrigeration: Definition, TOR, COP, relative COP, refrigerant, properties. Classification, vapour compression and vapour absorption refrigeration systems.

Psychometry and Air Conditioning: Definition, psychometric properties, dry bulb temperature, wet bulb temperature, dew point temperature, partial pressures, specific, absolute and relative humidity's, degree of saturation, adiabatic saturation temperature, enthalpy of moist air, psychometric relations, psychometric processes, summer and winter air-conditioning, numerical problems. **09 Hours**

Module - V

Gas Turbines and Jet propulsion: Classification of gas turbines, analysis of open cycle gas turbine cycle, methods to improve thermal efficiency, Jet propulsion and Rocket propulsion, numerical problems. **07 Hours**

Lab Experiments:

1. Determination of Caloric value of gaseous fuels.
2. Measurement of an area of Indicator diagram using planimeter.
3. Performance testing of 2-stroke air cooled, mechanically loaded petrol engine.
4. Studies on humidification of air.
5. Morse test on a multi-cylinder engine.
6. Performance testing of 4-stroke diesel engine with heat balance analysis.

Course outcomes:

On completion of this course, the students are able to :

- Describe the application of combustion thermodynamics.
- Analyze the various air standard cycles and vapour power cycles.
- Evaluate the performance of IC engines.
- An ability to understand the psychometric processes, the working of

air conditioning systems and refrigeration systems.

- Apply knowledge of gas turbines and jet propulsion.

Text Books:

1. P.K.Nag: “Basic and Applied Thermodynamics”, (Chapters 12-15,20,21), McGraw Hill Education India Private Limited, 5th Edition, 2013, ISBN: 978-1259062568.
2. Yunus A.Cenegal and Michael A.Boles: “Thermodynamics, An Engineering Ap- proach”, (Chapters 8-10,13), Tata McGraw Hill Publications, 8th Edition, 2014, ISBN-13: 978-0073398174.

Reference Books:

1. M L Mathur and R P Sharma: “Internal combustion engines”, (Chapters 2,26) Dhanpat Rai Publication, 3rd Edition, 2010, ISBN-13: 9788189928469.
2. R K Rajput: “Thermal Engineering”, (Chapters 9,10,15,16,21,23,25-27), Laxmi Publications, 9th Edition, 2013, ISBN-13: 978-8131808047.

E-Resources:

1. http://www.nptel.ac.in

Kinematics of Machines

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET44	4:0:0:0	4	CIE:50 SEE:50	3 Hours	F C

Course Objectives:

This course will enable students to :

- Understand the fundamental concepts of kinematics of machines and how to determine the mobility of mechanisms.
- Know the various mechanisms, its inversions and applications.
- Learn the velocity and acceleration analysis of mechanisms using graphical and instantaneous center method.
- Study the concepts of gear mechanism, gear train and terminologies involved in Spur gears.
- Understand the method of drawing cam profiles depending on type of motion.

Syllabus

Module - I

Introduction: Definitions of link or element, kinematic pairs, degrees of freedom, Grubler's criterion (without derivation), kinematic chain, mechanism, structure, mobility of mechanism, inversion, machine, kinematic chains and inversions. Inversions of four bar chain, single slider crank chain and double slider crank chain.

09 Hours

Module - II

Mechanisms: Quick return motion mechanisms – drag link mechanism, straight line motion mechanisms- Peaucellier's mechanism and Robert's mechanism, intermittent motion mechanisms – Geneva mechanism and ratchet and pawl mechanism, pantograph, Ackerman steering gear mechanism. **09 Hours**

Module - III

Velocity and Acceleration Analysis of Mechanisms (Graphical Methods): Velocity and acceleration analysis of four bar mechanism, slider cranks mechanism.

Velocity Analysis By Instantaneous Center Method: Definition, Kennedy's theorem, determination of linear and angular velocity using instantaneous center method.

09 Hours

Module - IV

Spur Gears: Gear terminology, law of gearing, characteristics of involutes action, path of contact, arc of contact, contact ratio, interference in involutes

gears, methods of avoiding interference, back lash, comparison of involutes and cycloidal teeth, numerical problems.

Gear trains: types of gear trains, epicyclic gear trains, Algebraic and tabular column methods of finding velocity ratio of epicyclic gear trains. **14 Hours**

Module - V

Cams: Types of cams, types of followers, displacement, velocity and acceleration time curves for cam profiles, disc cam with reciprocating follower having knife-edge, roller and flat faced follower, disc cam with oscillating roller follower. Follower motions including, SHM, Uniform velocity, uniform acceleration and retardation and cycloidal motion, numerical problems. **11 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Calculate mobility and enumerate rigid links and types of joints within mechanisms.
- Identify and select the proper mechanisms for application in real life situations.
- Construct the velocity and acceleration diagrams and determine the link velocities and accelerations.
- Identify different gears, gear trains and solve simple problems on spur gears and gear trains.
- Draw the cam profile for specific follower motion.

Text Books:

1. Sadhu Singh: “Theory of Machines”, (Chapters 1-8,11-13), Pearson Education,
   2nd Edition, 2007, ISBN-13: 9788177581270.
2. Thomas Bevan: “Theory of Machines”, (Chapters 1-15), CBS Publications, 3rd Edition, 2005, ISBN-13: 978-8123908748.

Reference Books:

1. Rattan S.S: “Theory of Machines”, (Chapters 1-16), Tata McGraw Hill Publishing Company Ltd. New Delhi, 4th Edition, 2014, ISBN-13: 9789351343479
2. Robert L. Norton, “Design of Machinery”, (Chapters 1-8), McGraw Hill, 5th Edition, 2011, ISBN-13: 978-0077421717.

E-Resources:

1. http://www.nptel.ac.in

Automobile Engineering-II

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET451	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Understand power trains and gear box.
- Develop skills in drive to wheels.
- Study the concept of suspension, springs and brakes.
- Impart the knowledge of automotive emission control system.
- Gain knowledge of basic parameters of engine test.

Syllabus

Module - I

Power Trains: Principle of friction clutches and constructional details, Fluid flywheel, Single plate, multi-plate and centrifugal clutches.

Gear box: Necessity for gear ratios in transmission, synchromesh gear box. Freewheeling mechanism, planetary gears systems, over drives, fluid coupling and torque converters, Epi-cyclic gear box, principles of automatic transmission, calculation of gear ratio. **08 Hours**

Module - II

Drive to wheels: Propeller shaft and universal joints, Hotchkiss and torque tube drives, differential, rear axle, different arrangements of fixing the wheels to rear axle, steering geometry, camber, king pin inclination, included angle, castor, toe in and toe out, condition for exact steering, steering gears, power steering- hydraulic and electric power assisted, over steer, under steer and neutral steer. **08 Hours**

Module - III

Suspension and springs: Requirements, Torsion bar suspension systems, leaf spring, coil spring, independent suspension for front wheel and rear wheel. Air suspension system.

Brakes: Types of brakes, mechanical, air, vacuum and hydraulic braking systems, construction and working of master and wheel cylinder, brake shoe arrangements, Disk brakes, drum brakes, Antilock-Braking systems, purpose and operation of antilock-braking system. **08 Hours**

Module - IV

Automotive emission control systems: Automotive emission controls, Controlling crankcase emissions, Controlling evaporative emissions, Cleaning the exhaust gas,

Controlling the air-fuel mixture, Controlling the combustion process, Exhaust gas recirculation, Treating the exhaust gas, Catalytic converter, Emission standards- Euro I, II, III and IV norms, Bharat Stage II, III norms. **08 Hours**

Module - V

Performance parameters and Engine Test Technology: Various performance parameters used for testing, Engine diagnosis, Electronic system testing and ECU diagnostics. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Describe working of power trains and gear box.
- Analyze the drive of wheels.
- Demonstrate the concepts of suspension, springs and brakes.
- Apply knowledge of emission control system.
- Evaluate the performance parameter andengine test.

Text Books:

1. William H Crouse and Donald L Anglin: “Automotive mechanics”, (Chapters 35- 38,42-47, 49-51), Tata McGraw Hill Publishing Company Ltd., 10th Edition, 2006, ISBN-13: 9780070634350.
2. S. Srinivasan: “Automotive Mechanics”, (Chapters 2,4,6-9), McGraw Hill Education (India) Private Limited, 2nd Edition, 2003, ISBN-13: 978-0070494916.

Reference Books:

1. R. B. Gupta: “Automobile Engineering”, (Chapters 24-26,29,30,41,42), Satya Prakashan Publisher, 4th Edition, 2015, ISBN-13: 9788176843799.
2. Kirpal Singh: “Automobile Engineering Vol I and II”, (Chapters 10,16), Standard Publishers, 12th Edition, 2011, ISBN-13: 9788180141713, 9788180141775.

E-Resources:

1. http://www.nptel.ac.in

2. http://elearning.vtu.ac.in/P6/enotes/ME44/Unit5-GR.pdf

Module -

Advanced Material Science

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET452	3:0:0:0	3	CIE:50 SEE:50	3 Hours	F E

Course Objectives:

This course will enable students to :

- Understand the various aspects related to composite materials and micromechanics of laminar.
- Gain the knowledge of powder metallurgy and its techniques.
- Study about materials for high temperature resistance and their applications.
- Impart knowledge of selection of different coating material and methods of surface technology.
- Know about nano particles, preparation methods, applications, characterization and also knowledge about carbon nanotubes and its types.

Syllabus

Module - I

Composite Materials: Classification of composites, types of matrices and reinforcements, characteristics and selection, particulate composites, laminates; sandwich structures, fabrication technologies for laminates and sandwich structures. Production of MMC's (Liquid Metallurgy, Squeeze casting, diffusion bonding), need for MMCs.

Micromechanics of laminae: Rule of mixture for evaluation of physical and elastic properties of laminae (density, thermal conductivity, elastic moduli, ultimate tensile strength), numerical problems. **08 Hours**

Module - II

Powder Metallurgy: Process details and special characteristics of powder metallurgy process. Compaction techniques like CIP and HIP (Cold isostatic and Hot isostatic pressing) Sintering, Applications of Powder metallurgy. **08 Hours**

Module - III

High temperature alloys: Classification of Titanium alloys, properties, microstructure and applications, heat treatment and machining of Ti alloys.

07 Hours

Module - IV

Surface technology: Coatings for specific applications, coating materials and their selection, coating technologies and their merits and demerits, coating characterization, Use of LASER for coating life enhancement, hard facing. **08 Hours**

Nanotechnology: Nano powders and nano materials, methods of preparation – plasma arcing, chemical vapour deposition, electro deposition, sol-gel synthesis, ball milling, comparative studies of the advantages and disadvantages of nano powder production technologies.

Carbon Nanotubes: Types of nanotubes, formation of nanotubes, advantages of nanotubes. Over nanopowders nanofabrication technologies, characterization of nanomaterials and nanostructured materials, AFM, STEM, XRD, FTIR for nano characterization. **09 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Describes necessity of composite materials in various fields of applications and its micromechanics.
- Apply the skills of effective production methods of powder metallurgy.
- Distinguish different types of high temperature resistance materials, proper- ties, microstructure and application.
- Analyze different methods of surface coating for best surface finishing pro- cess.
- Interpret various nano materials and preparation methods, utilization and understanding the necessity of nano materials.

Text Books:

1. Serope Kalpakjian and Steven R. Schmid: “Manufacturing Engineering and Technology”, (Chapters 4,5,10,11), Pearson Publication, 4th Edition, 2009, ISBN: 978-81-317-0245-1.
2. William D. Callister: “Materials Science and Engineering-an introduction”, (Chapters 4,10,13,15), John Wiley and Sons, 4th Edition, 2012, ISBN: 1118061608.
3. James F.Shackelford, M K Muralidahar: “Introduction to Materials Science for Engineers ”, (Chapters 1,7,9,10), Pearson Publication, 6th Edition, 2007, ISBN: 978-81-317-0090-7.

Reference Books:

1. Alan Cottrell: “An Introduction to Metallurgy ”, (Chapters 12,14-16,20),

Universities Press, 2nd Edition, 1990, ISBN: 8773712395.

2. Mick Wilson,Kamali Kannangara: "Nanotechnology–Basic Science and Emerging Technologies", (Chapters 1,3,4,6,9), New South Wales Press Limited, 2nd Edition, 2002, ISBN: 1420035231.

Air Pollution and Control

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET453	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- The fundamentals of air pollution with a background on historical perspective on air pollution and current air quality policies and standards.
- Major air pollutants, their sources and their effects (environmental, economic and health) and how emissions are estimated from road traffic and industrial sources.
- Dispersion of air pollutants in the atmosphere.
- Present outputs of air quality models to a wide range of audiences.
- Different air quality monitoring equipments.

Syllabus

Module - I

Introduction: Definition – Classification and Characterization of Air Pollutants, Emission Sources, Behavior and Fate of air Pollutants, Chemical Reactions in the Atmosphere, Photo-chemical Smog, Coal-induced smog, Air Pollution Inventories.

Effects of Air Pollution: On Human Health, Animals, Plants and Materials – Major Environmental Air Pollution Episodes – London Smog, Los Angeles Smog and Bhopal

Gas Tragedy. **09 Hours**

Module - II

Meteorology: Introduction – Meteorological Variables, Primary and Secondary Lapse Rate, Inversions, Stability Conditions, Windrose, General Characteristics of Stack Plumes, Meteorological Models. Factors to be considered in Industrial Plant Location and Planning, Noise pollution sources, measurement units, effects and control.

08 Hours

Module - III

Sampling, Analysis And Control: Sampling and Measurement of Gaseous and Particulate matter, Stack Sampling, Analysis of Air Pollutants, Smoke and Smoke Measurement, Air Pollution Control Methods – Particulate, Emission Control, Gravitational Settling Chambers, Cyclone Separators,

Fabric Filters, Electrostatic Precipitators, Wet Scrubbers, Selection of a Particulate Collecting Equipment.

09 HoursControl of Gaseous Emissions, Adsorption by Liquids, Adsorption by Solids, Combustion Odours and their control.

Air Pollution Due To Automobiles: Air Pollution due to Gasoline Driven and Diesel Driven Engines, Effects, Direct and Indirect Methods of control. **07 Hours**

Module - V

Burning Environmental Issues: Acid Rain, Global Warming, Ozone Depletion in Stratosphere, Indoor Air Pollution.

Environmental Legislation: Environmental Policy, Environmental Acts, Water, Air and Noise Pollution Standards. **07 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Examine emission standards for industrial and other sources.
- Identify air pollution concentrations as a function of emission, meteorology, topography and the built environment.
- Discuss impact of air pollution on health of humans, animals, plants and materials.
- Identify different equipments for air quality monitoring and control.
- Distinguish between global and local effects of air pollution and recognize legal aspects.

Text Books:

1. Rao M.N. and Rao H.V.N: “Air Pollution”, (Chapters 1-6), Tata-McGraw-Hill Publishing Company Ltd., New Delhi, India, 2011, ISBN-13: 978-0074518717.
2. Anjaneyulu Y: “Air Pollution and Control Technologies”, (Chapters 2-5), Allied Publishers, Delhi, 2012, ISBN-13: 9788177641844.
3. Rao C.S: “Environmental Pollution Control Engineering”, (Chapters 2-6), New Age International Publishers, New Delhi, 2nd Edition, 2013, ISBN-13: 978-8122418354.

Reference Books:

1. Gilbert M Masters: “Introduction To Environmental Engineering and Science”, (Chapters 1-4), Pearson Education, 3rd Edition, 2007, ISBN-13: 978-0131481930.
2. Mahajan.S.P: “Pollution Control in Process Industries”, (Chapters 1-5), Tata Mc- Graw Hill Publishing Co., New Delhi, 2010, ISBN-13: 978-0074517727.

E-Resources:

1. http://nptel.ac.in/courses/105102089/#
2. http://nptel.ac.in/courses/105104099/
3. nptel.ac.in/courses/103107084/module1/lecture1/lecture1.pdf

Renewable Energy Resources

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET461	3:0:0:0	3	CIE:50 SEE:50	3 Hours	E E

Course Objectives:

This course will enable students to :

- Provide detailed information of the present energy scenario and the avail- able Renewable Energy Resources.
- Get a detailed insight knowledge in basics of solar radiation geometry and various measurement techniques.
- Understand the solar energy through solar thermal devices, PV conversion and their performance analysis.
- Gain the conceptual knowledge about the various energy conversion methods such as wind ,Tidal, OTEC and Geothermal.
- Give introduction to Energy from Biomass, Hydrogen energy and their impact on environment and sustainability.

Syllabus

Module - I

Introduction: Energy source, India's production and reserves of commercial energy sources, need for non-conventional energy sources.

Solar Radiation: Extra-Terrestrial radiation, spectral distribution of extraterrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data.

Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. **08 Hours**

Module - II

Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle expression for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time. Apparent motion of sun, day length, numerical examples.

Radiation Flux on a Tilted Surface: Beam, diffuse and reflected radiation, expression for flux on a tilted surface (no derivations), numerical examples.

Solar Thermal Conversion: Collection and storage, thermal collection devices, liquid flat plate collectors, solar air heaters concentrating collectors (cylindrical, parabolic,paraboloid) (Quantitative analysis). **08 Hours**

Module - III

Performance Analysis of Liquid Flat Plate Collectors: General description, collector geometry, selective surface (qualitative discussion) basic energy-balance equation, stagnation temperature, transmissivity of the cover system, transmissivity – absorptivity product , numerical examples. The overall loss coefficient, correlation for the top loss coefficient, bottom and side loss coefficient, problems (all correlations to be provided). Temperature distribution between the collector tubes, collector heat removal factor, collector efficiency factor and collector flow factor, mean plate temperature, instantaneous efficiency (all expressions to be provided). Effect of various parameters on the collector performance; collector orientation, selective surface, fluid inlet temperature, number covers, dust. **09 Hours**

Module - IV

Photovoltaic Conversion: Description, principle of working and characteristics, applications.

Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind, major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis wind mills.

Tidal Power: Tides and waves as energy suppliers and their mechanics, fundamental characteristics of tidal power, harnessing tidal energy, limitations.

Ocean Thermal Energy Conversion: Principle of working, Rankine cycle,

Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram. **08 Hours**

Module - V

Energy from Bio Mass: Photosynthesis, photosynthetic oxygen production, energy plantation, bio gas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of bio-gas, problems involved with bio- gas production, application of bio-gas, application of bio-gas in engines, advantages. **Hydrogen Energy:** Properties of Hydrogen with respected to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal

decomposition of water, thermo chemical production bio-chemical production.

07

Hours

Course Outcomes:

On completion of this course, the students are able to :

- Explain the present energy scenario and the available Renewable Energy Re- sources.
- Describe the basics of solar radiation geometry and various measurement techniques.
- Analyze the knowledge gained in tapping the solar energy through solar thermal devices, pv conversion and their performance analysis.
- Demonstrate the various energy conversion methods such as Wind, Tidal, OTEC and Geothermal.
- Apply knowledge of Biomass and Hydrogen energy and their impact on environment and sustainability.

Text Books:

1. G D Rai: “Non-Conventional Energy Sources”, (Chapters 1-3,6-9,11), Khanna Publishers, 5th Edition, 2011, ISBN-13: 9788174090737.
2. John Twidell and Tony Weir: “Renewable Energy Resources”, (Chapters 1-2,5-7,9- 14), Routledge Publisher, 3rd Edition, 2015, ISBN-13: 978041558437.
3. N K Bansal: “Non-Conventional Energy Resources”, (Chapters 1-3,9,10,12,13), Vikas Publishing, 2014, 1st Edition, ISBN-13: 978935978577.

Reference Books:

1. B H Khan: “Non-Conventional Energy Resources”, (Chapters 4,5,6,7,8,9,10), Tata McGraw-Hill Pub., 2nd Edition, 2006, ISBN-13: 9780070142763.
2. S P Sukhatme, J K Nayak: “Solar Energy”, (Chapters 3,4), Tata McGraw-Hill Pub.,
   3rd Edition, 2008, ISBN-13: 9780070260641..

Object Oriented Programming with C++

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET462	3:0:0:0	3	CIE:50 SEE:50	3 Hours	E E

Course Objectives:

This course will enable students to :

- Understand features of object oriented Programming concepts.
- Understand inline functions, default arguments, classes and objects.
- Understand constructor, Types of constructor and destructor and their order of execution.
- Understand operator overloading and its necessity.
- Understand the virtual function, polymorphism, exception handling.

Syllabus

Module - I

Introduction: Origin of C++, features of OOP, Sample C++ program, Different data types, operators, expressions, implicit conversion, Type cast operator and statements, arrays and strings, pointers and user defined types, reference variable, memory management operator, name space, control structure, Function, default argument, inline functions, function overloading, recursive functions. **08 Hours**

Module - II

Classes and Objects: Classes, structures and classes are related. Friend functions, inline functions, Constructors, Different types of constructor, Destructors, Static data members, when constructor and destructors are executed, scope resolution operator. Nested classes, local classes, passing objects to functions, returning objects, this pointer. **08 Hours**

Module - III

Inheritance: Base Class, Inheritance, Types of inheritance and protected members, protected base class inheritance, inheriting multiple base classes, Constructors, Destructors and inheritance, Passing parameters to base class constructors, Granting access, Virtual base classes. **08 Hours**

Module - IV

Virtual functions, Polymorphism and Operator overloading: Operator over loading basics, creating a member operator function, Operator

overloading using friend functions such as +, - , pre-increment, post-increment, etc., overloading <<, >>. Virtual function, calling a Virtual function through a base class reference, Virtual attribute is inherited, Virtual functions are hierarchical, pure virtual functions, Abstract classes, Using virtual functions, Early and late binding. **09 Hours**

Generic function, Exception handling C++ File I/O: Generic function, a function with two generic types, Generic sort. Exception handling fundamentals, catching class types, using multiple catch, catching all exception.<stream>, and the file classes
,opening and closing file, reading and writing text files, put(), get(), read(), write(), geline(), eof(), seekg(), seekp(), tellp(), tellg(). **07 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Apply the concepts of object oriented programming.
- Implement the concepts of classes and objects.
- Apply the concepts of inheritance to solve complex problems.
- Implement mechanism of virtual function and polymorphism.
- Develop generic function to perform different operations on different data types and implement exception handling.

Text Book:

1. Herbert Schildt: "The Complete Reference C++", 4th Edition, Tata McGraw Hill, 2003, ISBN 13: 9780070532465.

Reference Books:

1. Stanley B.Lippmann, Josee Lajore: "C++ Primer", 4th Edition, Pearson Education, 2005, ISBN-10: 0-321-71411-3.
2. Paul J Deitel, Harvey M Deitel: "C++ for Programmers", Pearson Education, 2009, ISBN-10: 0137059663.

E-Resources:

1. http://www.tutorialspoint.com/cplusplus/cpp_tutorial.pdf
2. http://www.ddegjust.ac.in/studymaterial/mca-3/ms-17.pdf

Management Information Systems

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET463	3:0:0:0	3	CIE:50 SEE:50	3 Hours	E E

Course Objectives:

This course will enable students to :

- Effectively use and administrate information systems in different business applications.
- Understand problem solving techniques to model information system solutions for business problems.
- Understand the business and professional responsibilities related to the use of information system in organizations.

Syllabus

Module - I

Foundations of information systems in business: Introduction to Information Systems in Business: Why study Information Systems? What you need to know, A global Information society, Success and Failure with IT, Why Businesses need Information Technology. Fundamentals of Information Systems: Fundamental Information System concepts: System concepts, Components of an Information System, Information System Resources, Information System activities, Overview of Information Systems: The expanding Role of Information Systems, Operations support Systems, Management support Systems, Other classifications of Information Systems. **08 Hours**

Module - II

Solving Business Problems with Information Systems: A Systems Approach to problem Solving: The Systems approach, Defining problems and opportunities, Developing alternative solutions, Evaluating Alternative solutions, Selecting the best solution, Using the Systems approach. Developing Information System Solutions: The system development cycle, Starting the Systems Development process, Systems Analysis, Systems Design, Prototyping, Implementing a new Information System, Maintenance of Information System, Computer Aided Systems Engineering, End user development.

Business applications – I

The Internet, Electronic Commerce and Business: Introduction, Business use of the Internet, Interactive marketing, Business value of the Internet,

Customer value and the Internet. Fundamentals of Electronic Commerce: Introduction, Foundations and applications of e -commerce, Business to Consumer and Business to Business commerce, Electronic payments and security. **08 Hours**

Module - III

Intranets, Extranets, and Enterprise Collaboration: Intranets and Extranets in Business: Business Value, Applications and Technologies for Intranets, Role of Extranets, Enterprise Collaboration Systems: Enterprise Collaboration, GroupWare, Electronic communication and conferencing tools, collaborative work management tools. Information Systems for Business Operations: Business Information Systems: Cross Functional Marketing, Manufacturing, Human Resources, Accounting and Financial Information Systems. **08 Hours**

Module - IV

Transaction Processing Systems: Transaction Processing, Data entry, Batch and Real- time processing, Database maintenance, Document and Report generation, Inquiry processing.

Business applications - II

Information Systems for Strategic Advantage: Introduction, Competitive strategy, Strategic Roles for Information System, Breaking Business Barriers, Value chain and strategic Information System, Strategic Applications and Issues in information Technology, Reengineering Business process, Improving Business quality, Becoming an agile competitor. Creating a virtual Company, Building the knowledge-creating company, Using the Internet Strategically. **08 Hours**

Module - V

Managing information technology: Enterprise and global Management: Managing Information Resources and Technologies: Information Technology Architecture, Managers and Information Technology, Organizations and Information Technology, Information Resource Management, Strategic Management Operational Management, Resource Management, Technology Management, Global Information Technology Management: The International Dimension, Global IT Management, Cultural, Political and Geo -Economic challenges, The global company, Global Business and IT strategies, Global

Business and IT applications, Global IT Platforms, Global data Issue, Global Systems development, You and Global IT Management. Planning Implementing change: Planning for Business change with IT: Organizational planning, Information System planning Methodologies, The scenario approach, planning for competitive advantage, Critical success factors, Business Systems Planning, Computer Aided Planning tools, implementing business change. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Describe the roles and functionalities of information system.
- Analyze types of solutions for business and its applications.
- Analyze the usage of Intranet and Extranet in business applications.
- Describe database management and competitive strategic approach of information systems in business applications.
- Describe various approaches in managing information technology.

Text Book:

1. James O'brien, George Marakas: "Management Information System", 10th Edition, Mcgraw-Hill Education, 2010, ISBN-13: 978-0-07-337681-3, ISBN: 0-07- 337681-7.

Reference Books:

1. Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm, 11th Edition, Pearson Education, 2006.
2. Steven Alter: Information Systems The Foundation of E-Business, 4th Edition, Pearson Education, 2002.

E-Resources:

3. https://books.google.co.in/books/about/Management_Information_System. html.
4. http://www.pearsoned.co.uk/bookshop..

Smart Materials

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET464	3:0:0:0	3	CIE:50 SEE:50	3 Hours	E E

Course Objectives:

This course will enable students to :

- Understand the characteristics of composites and smart materials in the product design process.
- Know the types of sensing and actuation devices.
- Gain the knowledge of optics and electromagnetic technology.
- Study the importance of different control systems.
- Realize and understand the principles of vibration and modal analysis.

Syllabus

Module - I

Introduction: Characteristics of composites and ceramics materials, Dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics.

Control Design: Design of shape memory alloys, Types of MR fluids, Characteristics and application, principles of MR fluid value designs, Magnetic circuit design, MR Dampers, Design issues. **08 Hours**

Module - II

Sensing and Actuation: Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, their compatibility writer, conventional and advanced materials, signal processing, principles and characterization. **08 Hours**

Module - III

Structures: Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects.

Optics and Electromagnetic: Principles of optical fiber technology, characteristics of active and adaptive optical system and components, design and manufacturing principles. **08 Hours**

Module - IV

Controls: Principles of structural acoustic control, distributed, analog and

digital feedback controls, Dimensional implications for structural control. **08 Hours**

Module - V

Principles of Vibration And Modal Analysis: PZT Actuators, MEMS, Magnetic shape Memory Alloys, characteristics and Applications.
Information Processing: Neural Network, Data Processing, Data Visualisation and Reliability-Principles and Application domains. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Explain the characteristics of composites and smart materials in the product design process.
- Identify various types of sensing and actuation devices.
- Analyze the optics and design structures using smart materials.
- Demonstrate the working principles of different control systems.
- Describe the principles of vibration and modal analysis.

Text Books:

1. A V Srinivasan, D Michael Mcfarland: "Smart Structures, Analysis and Design", (Chapters 2-5,7,8), Cambridge University Press, 1st Edition, 2001, ISBN-13: 9780521659772.
2. M V Gandhi, B S Thomson: "Smart Materials and Structures", (Chapters 13-75), Chapman and Hall Pub., 1st Edition, 1992, ISBN-13: 9780412370106.

Reference Books:

1. Eric Udd: "Fiber Optic Sensors: An introduction for Engineers and Scien- tists", (Chapters 1-16), John Wiley and Sons Pub., 2nd Edition, 2011, ISBN-13: 9780470126844.
2. G P Gibss: "Adaptive Structres", John Wiles and Sons, New York, 1998.
3. Banks H T, R C Smith, Y Wang, Massow S A: "Smart Materials and Structures", Paris, 1996.

Machine Shop Laboratory

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEL47	1-0-2:0	2	CIE:50 SEE:50	3 Hours	F C

Course Objectives:

This course will enable students to :

- Understand the various types of Lathe, shaping and planning operations
- Conduct and operate the machines to obtain desired shape and size.
- Study concept of milling operations and indexing mechanism.
- Find the method of making slots / keyways using shaping machine.

Syllabus

PART-A

Lathe Machine Operations: Preparation of three models on Lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning, jobs involving 3 jaw and use of 4 jaw chuck.

PART-B

Milling Machine Operations: Cutting of Spur Gear Teeth (gear tooth calculation).
Shaping Machine: Cutting of - V/Dovetail/Rectangular Grooves.

Course Outcomes:

On completion of this course, the students are able to :

- Describe the knowledge and the skills required with respect to the operation, procedure, conduction and analyzing the results of experiments.
- Operate the lathe, shaping and milling machines.
- Demonstrate the operations in Lathe, Milling, Shaper, Grinding and Drilling machines.

Conducting classes: Classes may be conducted in one slot per week, of 3 Hours (Instruction 1 hr. + Conduction and Calculation 2 hr.)

Scheme of Examination:

ONE question from part -A : 30 Marks
ONE question from part -B : 10 Marks
Viva -Voce : 10 Marks

Total	**: 50 Marks**

Material Testing Laboratory

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEL48	1-0-2:0	2	CIE:50 SEE:50	3 Hours	F C

Course Objectives:

This course will enable students to :

- Understand the wear characteristics of ferrous, non-ferrous and composite materials.
- Conduct the NDT tests.
- Study the defects in cast and weld specimens.
- Find the concept of tensile, shear and compression tests using UTM machine.
- Understand the behaviour of material for impact, wear loads and also to know the effect of heat treatment.

Syllabus

List of Experiments:

1. Preparation of Specimen for Metallographic Examination of Different Engineer- ing Materials. (Identification of Microstructures of plane carbon steel, tool steel, gray C.I, SG iron, brass and bronze).
2. Heat treatment: Annealing, Normalizing and Hardening of steel.
3. To study the wear characteristics of ferrous and non-ferrous materials.
4. Tensile, Shear and Compression tests of metallic specimen using a Universal Test-ing Machine.
5. To carryout bending test on Metallic and Non Metallic Specimens.
6. To find the impact strength of ferrous material using Izod and Charpy Tests.
7. To find the hardness of ferrous and non-ferrous materials using Brinell and Rock- well tester.
8. To locate surface-breaking defects in all non-porous materials using dye penetration testing.

9. To detect surface / slightly subsurface discontinuities in ferromagnetic materi-als using magnetic crack detection.

Course Outcomes:

On completion of this course, the students are able to :

- Demonstrate the knowledge and the skills required for the procedure, conduction and analyzing the results of Tensile, Shear and Compression, Torsion, Bending Test.
- Analyze the Identification of metals and Microstructures.
- Capable of detecting the defects by using the NDT methods.
- Know the material behaviour for impact and wear loads.

Conducting classes : Classes may be conducted in one slot per week of 3 Hrs (Instruction 1 Hr + Conduction and Calculation 2 Hrs)

Scheme of Examination:

Individual Experiment	: 15 Marks
Group Experiment	: 25 Marks
Viva –Voce	: 10 Marks
Total	**: 50 Marks**

Integrated Rural Development – Part 2

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEL49	0:2:0: 0	1	CIE:50 SEE:50	2 Hours	HSS

Course Objectives:

This course is an extension of the Integrated Rural Development course which was introduced in Semester 3. This course will extend the previous semester's work and will enable the students to:

- Continue working on the problems and challenges identified in the village.
- Apply their academic knowledge, talents, and abilities to come up with innovative and practical solutions to the challenges in the village.
- Foster a sense of entrepreneurship towards addressing the problems in the village.

Syllabus

Module - I

Overview: Overview of the course; summary of the experiences from previous semester with assigned mentors and supervisors; discussion of the challenges faced in the village identified previously. **03 Hours**

Module - II

Project Backlog Revision: Revisiting the challenges already identified in the previous semester and identifying possible project topics with the help of mentor and supervisor (this can be either continuation of the previous semester's project with a larger scope or a new project); student group discussion to finalize the new project definition; review of project definition with mentor and supervisor. **06 Hours**

Module - III

Project Plan Finalization: Modification of the previous semester's project plan to accommodate the new objectives; review of new proposaland plan with mentor and supervisor to finalize plan of work; distribution of workand needed resources and logistics within the group. **06 Hours**

Module - IV

Project Execution: Execution of the project as per the plan;conducting

surveys to evaluate the impact of the project execution; collection ofproject deliverables; periodical review of the project execution status and collected artifacts (like aggregated data and survey reports) with mentor and supervisor. **10 Hours**

Module - V

Project Presentation: Creation of a final project report and a high-quality project presentation; both the project report and presentation should clearly articulate the motivation, how the project was conceptualized and executed, impact of the project, futuredirections in the project, and lessons learned by the students during the project; final review and evaluation by mentor and supervisor. **03 Hours**

Course Outcomes:

On completion of this course, students will be able to:

- Further develop their social and communication skills by interacting with residents of the village and within their team.
- Conceptualize long term solution to challenges in villages, thus developing a sense of entrepreneurship.
- Make an impact to rural sections of society, thus building their self-confidence.

Text Books:

1. Bhagawan Sri Sathya Sai Baba: “Service to Village is Service to God”, Sri Sathya Sai Publications.

Reference Books:

1. Bhagawan Sri Sathya Sai Baba: “Man Management: A Value-Based Management Perspective”, Sri Sathya Sai Publications.
2. Lt. Gen. M.L.Chibber: “Sai Baba’s Mahavakya on Leadership : Book for Youth, Parents and Teachers.”

E-Resources:

1. http://rural.nic.in/netrural/rural/index.aspx
2. www.annapoorna.org.in

Machine Design-I

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET51	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the differences between design and analysis and introduction to fundamental notations and approaches to design.
- Learn fundamental approaches to failure, prevention for static and repeated loading.
- Study the component behavior for fatigue or fluctuating load and to design the components for fatigue.
- Study of power necessary for driving power screws at different speeds and torques.
- Design of specific machine elements like keys and shafts by applied analysis technique.

Syllabus

Module – I

Introduction: Basic procedure of machine design, basic requirement of machine elements, design of machine elements, traditional design methods, Design considerations: codes and Standards, Stress Analysis, selection of material, mechanical properties of materials, Definitions: normal, shear, biaxial and tri-axial stresses, Stress tensor, Principal Stresses, Static Strength, Static loads and factor of safety. **08 Hours**

Module – II

Theories of failure and Stress concentration: Introduction to theories of elastic failure Maximum normal stress theory, Maximum shear stress theory, Distortion energy theory; Failure of brittle materials, Failure of ductile materials. Selection and use of failure theories, Stress concentration, reduction of stress concentration, Determination of Stress concentration factor for axial, bending, torsion and combined loading.

Impact loads: Introduction, Impact stresses due to axial and bending. **10 Hours**

Module – III

Design for Fatigue Load: Introduction- S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit, Endurance limit modifying factors: size effect, surface effect, Stress concentration effects; Fluctuating stresses, Goodman and Soderberg relationship; stresses due to combined loading, cumulative fatigue damage.

08 Hours

Module – IV

Power Screws: Need of power screws, Advantages and disadvantages, types of threads and their applications, terminology of power screws, Mechanics of power screw(torque required to rise and lower the load), Stresses in power screws, efficiency and self-locking, Design of Power Screw. **08 Hours**

Module – V

Design of shafts: Torsion of shafts, design for strength and rigidity with steady load, types of shafts, properties of shaft material, heat treatment of shaft, methods of manufacturing shafts, ASME codes for power transmission shafting, forces acting on the shaft due to belt drive.

Keys: Introduction, functions of keys, Types of keys, specifications of keys, selection of keys Design of keys. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Analyze the stress and strain on mechanical components and understand, identify and quantify failure modes for mechanical parts.
- Describe the concepts of failure theories and the components subjected to
  impact load and apply them in machine design.
- Estimate safety factors of simple structures exposed to static and repeated loads.
- Design and analyze the power screws.
- Design keys and shafts for rotating machinery.

Design Data Hand Books:

1. K. Lingaiah: “Design Data Hand Book”, McGraw Hill, 2nd Edition, 2003.
2. K. Mahadevan, Balaveera Reddy: “Design Data Hand Book”, CBS Publication.
3. H.G. Patil Machine: “Design Data Hand Book”, Shri Shashi Prakashan, Belgaum.

Text Books:

1. Joseph E Shigley, Charles R. Mischke, “Mechanical Engineering Design”, (Chapterss- 1,2,5,7), Tata McGraw Hill Publishing Company Ltd., New Delhi, 8th Edition, 2008, ISBN: 978-0-07-066861-4.
2. V.B. Bhandari, “Design of Machine Elements”, (Chapters-1,2,4,5,6,7,8,9), Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2013, ISBN: 978-0-07-068179-8.

Reference Books:

1. Robert L. Norton: “Machine Design”, (Chapters-1,3,4,5,6,9,14), Pearson Education Asia, 2nd Edition, 2000, ISBN: 978-0-07-014480-4.
2. M.F.Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram, C.V. Venkatesh: “Design of Machine Elements”(Chapters- 1,2,5,7), Pearson Education, 8th Edition 2006 ISBN: 81-7758-421-9.
3. Sharma, Purohit C.S, Kamalesh: “Design of Machine Elements” (Chapters 1,2,5,6) Pearson publications, New Delhi, 2nd Edition, 2003, ISBN: 81-203-1955-9.

E-Resources:

1. http://nptel.ac.in/courses/112105124/
2. https://ocw.mit.edu/courses/mechanical-engineering/2-72-elements-of-mecha
   nical-design

Dynamics of Machines (IC)

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEI52	3:0:2: 0	4	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Learn the principle of static and dynamic force on different mechanisms.
- Understand the concept of friction in different bearings and parameters of belt drives.
- Know the balancing of rotating masses.
- Expose the application and parameters of governors.
- Gain basic knowledge of gyroscopic effect on different vehicles.

Syllabus

Module – I

Static Force Analysis: Introduction: Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams, Principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism without friction and numericals on force analysis. **08 Hours**

Module – II

Friction and Belt Drives: Definitions: Types of friction, laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives. Ratio of belt tensions, centrifugal tension, power transmitted, numericals. **10 Hours**

Module – III

Balancing of Rotating Masses: Static and dynamic balancing. Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes and numericals. **08 Hours**

Module – IV

Governors: Types of governors; force analysis of Porter and Hartnell governors. Controlling force, Stability, sensitiveness of governors. Isochronism, effort and power of governors and numericals. **08 Hours**

Module – V

Gyroscope: Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers and numericals. **10 Hours**

Lab experiments:

1. To find the Pressure distribution in Journal bearing.
2. Determination of static and dynamic balancing of Masses.
3. To find the equilibrium speed, sensitiveness, power and effort of Porter/Prowel / Hartnel Governor.
4. Determination of gyroscopic effect on disc.
5. Demonstration on various kinematic linkages and mechanisms.

Course Outcomes:

On completion of this course, the students are able to:

- Carry out static force analysis on different mechanisms.
- Find the friction and various parameters of bearings and belt drives.
- Solve the problems on balancing of rotating masses in same and different planes.
- Explain and solve simple problems related to the different governors.
- Determine gyroscopic effect on different vehicles.

Text Books:

1. Sadhu Singh: "Theory of Machines",(Chapterss-1-3,5-7,12), Pearson Education,
   2nd Edition, 2007, ISBN-13: 9788131760697.
2. Rattan S.S.: "Theory of Machines", (Chapters 2,3,8,9,14,16,17), Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009, ISBN-13: 9780070144774.
3. J.S.Brar, R.K. Bansal: "Theory of Machines", (Chapters 3,4,6,7,13,14,17,21), Lakshmi Publication Ltd., New Delhi, 3rd Edition, 2004, ISBN-13: 9788131808054.

Reference Books:

1. J.J. Uicker, G.R.Pennock, J.E. Shigley: "Theory of Machines & Mechanisms", (Chapters- 3,4,16,19,20), Oxford Publication, 3rd Edition, 2009, ISBN-13: 9380198062325.
2. A.G.Ambekar: "Mechanism and Machine Theory", (Chapters 3,4,11,12,16,17,10), PHI, 2009, ISBN-13: 9788131560697.
3. R. S. Khurmi, J.K. Gupta: "Theory of Machines", (Chapters 6-8,10,11,14,18,21,22), Eurasia Publication House Ltd., 3rd Edition, 2004, ISBN-10: 812192524X.

E-Resources:

1. http://nptel.ac.in/courses/112104114/
2. http://nptel.ac.in/courses/112101096/
3. https://cosmolearning.org/courses/dynamics-of-machines/video-lectures/

Artificial Intelligence and Robotics

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET53	3:0:0: 0	3	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the role of basic knowledge representation, problem solving and learning methods in AI in Robotics Engineering
- Know the parts of robots, types of robots and basic mathematical concepts related to design of robot.
- Study the concept of statics and kinematics of robot manipulator along with velocity analysis.
- Develop the dynamics of manipulator and trajectory planning.
- Impart the various drive systems for robot, sensors, actuators and their applications in robots and programming of robots.

Syllabus

Module – I

Introduction to Artificial Intelligence: Definition, goals of AI research, importance of AI and AI related field, Goals of AI research, AI techniques, knowledge representation, techniques for representing knowledge, logic, procedural representation, semantic network, production systems, other representation techniques, problem representation and problem solving, search techniques in problem solving, LISP programming, AI and Robotics, LISP in the factory. **06 Hours**

Module – II

Introduction and Mathematical Representation of Robots: Types of Robots, End Effectors, Notation, Position and Orientation of a Rigid Body, Some Properties of Rotation Matrices, Successive Rotations, Euler Angles For fixed frames X-Y-Z and moving frame ZYZ. Transformation between coordinate system, Homogeneous coordinates, Properties of A T B , Types of Joints: Rotary, Prismatic joint, Cylindrical joint, Spherical joint, Representation of Links using Denvit- Hartenberg Parameters: Link

parameters for intermediate, first and last links, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator. **08 Hours**

Module – III

DK and IK of manipulators: Degree of freedom of a manipulator, Direct kinematics of serial and parallel manipulator, Inverse kinematics of serial manipulator.

Velocity analysis and Statics of Manipulators: Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of serial and parallel manipulators.

09 Hours

Module – IV

Dynamics of Manipulators: Kinetic energy, Potential energy, Equation of motion using Lagrangian, Inertia of a link, Recursive formulation of Dynamics using Newton Euler equation, Equation of motion of 2R manipulator using Lagrangian, Newton- Euler formulation.

Trajectory Planning: Joint space schemes, cubic trajectory, Joint space schemes with via points, Cubic trajectory with a via point, Cartesian space schemes, Cartesian straight line and circular motion planning. **09 Hours**

Module – V

Robot Programming: Introduction, Manual teaching, lead through teaching, programming languages, VAL II, simple example of palletization.

Actuators and Sensors: Types, Characteristics of actuating system: weight, powerto- weight ratio, operating pressure, stiffness vs. compliance, Use of reduction gears, comparison of hydraulic, electric, pneumatic actuators, sensor, types of sensor.

08 Hours

Course Outcomes:

On completion of this course, the students are able to:

- Describe of the basic knowledge gained in Artificial Intelligence in Robotics.
- Demonstrate the different classes of robot & explain how you to select a specific class of robot for industrial application.
- Evaluate the different industrial robot based on kinematic and dynamic analysis.

- Develop different programming in robotics depending upon application.
- Identify the general type of sensors & actuator associated with industrial applications.

Text Books:

1. Stuart J Russel, Peter Norvig: "Artificial Intelligence", (Chapters-1,3,6,25), Pearson Education India, 3rd Edition, 2017, ISBN: 978-9332543517.
2. Ashitava Ghosal: "Robotic Fundamental Concepts and Analysis", (Chapters- 1-7),Oxford University Press, 4th Edition, 2009, ISBN-13: 9780195673913.
3. Mikell P Groover, Mitchell Weiss: "Industrial Robotics, (Chapters-1,2,4-6,8-10), Mc GrawHill, 2003, ISBN: 978-0071004428.

Reference Books:

1. David Cook: "Robot Building for beginners", (Chapters 1,2,4,5), Apress, 2nd Edition, 2010, ISBN: 978-1430227489.
2. Robert J Schilling: "Fundaments of Robotics, analysis and control" (Chapters 1-6,9), Prentice Hall India Learning Private Limited, 2010, ISBN: 978-8120310476.

E-Resources:

1. http://nptel.ac.in/courses/106105077/
2. http://nptel.ac.in/courses/112101099/
3. http://nptel.ac.in/courses/112101098/
4. https://see.stanford.edu/Course/CS223A

Fluid Mechanics (IC)

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEI54	3:0:2:0	4	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the basic concepts and recognize the various types of fluid flow, Also variation of Pressure in a fluid is at rest.
- Study the concept of Euler's equation and extracting Bernoullis's equation from it and Devices commonly used for flow measurement.
- Know the reasons for Major and minor loss of energy through pipe and use of dimensional analysis to design physical or numerical experiments and to apply dynamic similarity.
- Impart the Heat losses in laminar and turbulent flow through pipes.
- Learn the concept of Buoyancy and importance of continuity equation and can implement the compressible flow and flow around immersed bodies.

Syllabus

Module – I

Properties of fluids: Introduction to fluid mechanics & its applications, properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitation.

Fluid Statics: Fluid Pressure at a Point, Pascal's Law, Pressure variation in a Static Fluid, Absolute, Gauge, Atmosphere and Vacuum Pressure, Manometers, Problems.

09 Hours

Module – II

Fluid Dynamics: Introduction, equations of motion, Euler's equation of motion, Bernoulli's equation from Euler's equation, Limitation of Bernoulli's equation.

Fluid flow measurements: Introduction, Hydraulic coefficients, Venturimeter, orifice meter, Pitot tube, V-notch and Rectangular notch. **10 Hours**

Module – III

Flow through pipes: Frictional loss in pipe flow, Darcy's-Equation and Chezy's equation for loss of head due to friction in pipes.

Dimensional Analysis: Introduction, derived quantities, dimensions of Physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham's π theorem, dimensionless numbers and their significance. **08 Hours**

Module – IV

Laminar flow and viscous effects: Reynolds experiment, critical Reynolds number, Laminar flow through circular pipe-Hagen poiseulle's equation, Laminar flow between parallel plates.

Fluid Kinematics and Buoyancy: Buoyancy, center of buoyancy, metacenter and metacenter height, Conditions of equilibrium of floating and submerged bodies. Types of fluid flow- Introduction, Continuity equation in three dimensions (Cartesian co-ordinate system only), velocity and acceleration, velocity potential function and stream function. **09 Hours**

Module – V

Introduction to compressible flow: Velocity of sound in a fluid and its expression for isothermal and adiabatic flow. Mach number, Propagation of pressure waves in a compressible fluid.

Flow past immersed bodies: Drag, Lift, expression for lift and drag, pressure drag and friction drag, boundary layer concept, displacement thickness, momentum thickness and energy thickness. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to:

- Identify the type of fluid also able to apply Pascal's law in problems and they should realize the function of manometers.
- Apply the Bernoulli equation to solve problems in fluid mechanics and can demonstrate about fluid flow measuring devices and its areas of applications.
- Analyze the reason for energy losses in pipes and ability to perform dimensional analysis for problems in fluid mechanics.
- Demonstrate the distribution of shear stress and velocity during laminar flow.
- Describe the basic concepts viz. buoyancy, floatation, friction in pipe flow, lift and drag.

Laboratory Experiments:

1. Verification of manometric equation.
2. Study on Flow Meter.
3. Determination of Friction losses in pipe.
4. Determination of Reynold's number.
5. Measurement of lift and drag forces (Virtual lab).

Text Books:

1. Dr. Bansal R.K: "Fluid Mechanics and Hydraulic Machines", (Chapters 1,2,4,6,8,9, 11,12), Lakshmi Publications, 9th Edition, 2017, ISBN: 978-81-318-0817-3.
2. Dr. K Subramanya: "Fluid Mechanics and Hydraulic Machines", (Chapters 1-3,6- 9,11), Tata McGraw Hill Publicatons, 2014, ISBN: 978-0-07-069980-9.
3. Dr. Jagadish Lal: "Fluid Mechanics and Hydraulics", (Chapters 2,4,6,8-10,13), Metropolitan Book Co. Ltd., 9th Edition, 2008, ISBN: 978-8120004221.

Reference Books:

1. P.N. Modi and Seth: "Hydraulics and Fluid Mechanics", (Chapters 1,2,4,9), 20th Edition, 2013. ISBN: 978-8-18-940126-9.
2. Kumar.D.S, Kataria and Sons: "Fluid Mechanics and Fluid Power Engineering", (Chapters 1-6,9-11,13), 9th Edition, 2013, ISBN: 978-9350143926.

E-Resources:

1. http://nptel.ac.in/courses/112105171/1
2. http://nptel.ac.in/courses/112105183/
3. https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-01-unified- engineering-i-ii-iii-iv-fall-2005-spring-2006/fluid-mechanics/

Composites Material Technology

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET551	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Learn the basic concepts of the composite materials.
- Understand the different processing/ fabrication techniques of polymer composite materials.
- Gain the knowledge of metal matrix composites and it's manufacturing techniques.
- Know the different methods to produce ceramic matrix composite materials.
- Impart application of composite materials in different aspects.

Syllabus

Module – I

Introduction to Composite Materials: Historical Background, Definition, Need for developing composite materials, Classification of composites, Desirable characteristics of fiber Reinforced Composites, Types of matrices material and reinforcements, Interfaces in composites, Advantages and Disadvantages of composites. **08 Hours**

Module – II

Polymer Matrix Composites: Introduction polymer matrix composites, Different methods of fabrication of PMC's : open mould and closed mould, Laying up and curing, Structure and mechanical properties, Advantages and Disadvantages of PMC's. **08 Hours**

Module – III

Metal Matrix Composites: Introduction metal matrix composites, Types of metal matrix composites, Important metallic matrices, Types and Characteristics of reinforcement materials, Processing, Mechanical properties, Advantages and Disadvantages of PMC's. **08 Hours**

Module – IV

Ceramic Matrix Composites: Introduction to Ceramic matrix composites, different processing techniques for ceramic matrix composites, Mechanical properties of ceramic matrix composites, Advantages and Disadvantages of CMC's. **08 Hours**

Module – V

Application Developments: Aircraft, Missiles, Space Hardware, Automobile, Marine, Electrical and Electronics, Recreational and Sports equipment-future potential of composites. **08 Hours**

Course Outcomes:

Upon the completion of the course, the student should be able to,

- Recognize the different types of Composite materials.
- Describe the different manufacturing methods to produce polymer matrix composites.
- Demonstrate the processes of metal matrix composites.
- Analyze different production methods to produce ceramic matrix composites.
- Identifying the suitable applications of composite materials.

Text Books:

1. Krishan K. Chawla: "Composite Materials and Engineering", (Chapters 1-5,7,8), Springer (India) Private Limited, 2nd Edition, 2010, ISBN: 978-81-8128-490-7.
2. Robert M. Jones: "Mechanics of Composite Materials", (Chapters 1, 2, 3), Taylor and Francis, 2nd Edition, 2013, ISBN: 1-56032-712-X.

Reference Books:

1. D. Hull and T. W. Clyne: "An Introduction to Composite Materials", (Chapters 1-4), Cambridge University Press, 2nd Edition, 2008, ISBN: 978-0-521-73548-3.
2. Madhujit Mukhopadhyay: "Mechanics of Composite materials and Structures", (Chapters 1,2), Universities Press, 2013, ISBN: 978-81-7371-477-1.
3. Autar K. Kaw: "Mechanics of Composite Materials", (Chapter 1), Taylor and Francis, 2nd Edition, 2009, ISBN: 0-8493-1343-0.

E-Resources:

1. http://nptel.ac.in/courses/112104168/
2. http://freevideolectures.com/Course/3479/Processing-of-non-metals/5

Power Plant Engineering

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET552	3:0:0: 0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Understand the working of steam engine power plant with various part functioning
- Study the function of ash handling system and various boilers
- Learn Diesel Engine Power plant Function and Power generated by Hydro Electric Power Plant
- Know about Chimneys and Accessories used and Importance of Site Selection
- Impart the information about Nuclear Power Generation and Economic Analysis of Generating Power

Syllabus

Module – I

Steam Power Plant: Different types of fuels used for steam generation, Equipment for burning coal in lump form, strokers, different types, Oil burners, Advantages and Disadvantages of using pulverised fuel, unit system and bin system. **07 Hours**

Module – II

Coal, Ash Handling and Different Types of Boilers: Coal and Ash handling, Generation of steam using forced circulation, high and supercritical pressures, A brief account of LaMount, Benson, Velox, Schmidt, Loeffler and Ramson steam generators.

09 Hours

Module – III

Diesel Engine and Gas Turbine Power Plant: Method of starting diesel engines, Cool- ing and lubrication system for the diesel engine. Intake and exhaust system, Layout of a diesel power plant.

Hydroelectric Power Plant: Hydro-Electric Plants: Storage and pondage, flow duration and mass curves, hydrographs, Low, medium and high head plants, pumped storage plants, Penstock, water hammer, surge tanks. **08 Hours**

Module – IV

Chimneys, Accessories for the Steam Generator Cooling Towers And Ponds: Natural, forced, induced and balanced draft, Study of different types of cooling towers and ponds.

Choice of site for power station: load estimation, load duration curve, load factor, capacity factor, use factor, diversity factor, demand factor, Effect of variable load on power plant. **08 Hours**

Module – V

Nuclear Power Plant: Principles of release of nuclear energy Fusion and fission reactions. Nuclear fuels used in the reactors. Multiplication and thermal utilization factors. Elements of the Nuclear reactor, Moderator, control rod, fuel rods, coolants. **Economic Analysis of Power Plant:** Cost of energy production, selection of plant and generating equipment, performance and operating characteristics of power plants.

08 Hours

Course Outcomes:

Upon the completion of the course, the student should be able to,

- Deliver a talk on Steam Engine Power Generation.
- Suggest the best method of Ash handling System and Boiler needed.
- Analyze Power Generated by Diesel Engine and can effectively draw hydrograph and Flow duration curves.
- Demonstrate the functions of Chimneys and can explain role of site selection.
- Realize the functioning of Nuclear Power Generation and Important factors helps to reduce the cost of power generation.

Text Books:

1. Dr. P K Nag: “Power Plant Engineering”, (Chapters 1,2,4,6,9,10), Tata McGraw Hill Publicatons, 3rd Edition, 2009, ISBN-13: 978-0-07-064817-9.
2. R K Rajput: “Power Plant Engineering”, (Chapters 1-6,8-10), Lakshmi

Publicatons, 2009, ISBN-13: 978-81-318-0255.

Reference Books:

1. Manoj kumar gupta: “Power Plant Engineering”, (Chapters 1-5), PHI Publishing,
   1st Edition, 2012, ISBN: 9788120346123.
2. Skrotizke and V Opat: “Power station Engineering”, (Chapters 1,2), McGraw-Hill,
   2nd Revised Edition, 2012, ISBN: 978-0070579408.

E-Resources:

1. http://nptel.ac.in/courses/108105058/8
2. http://nptel.ac.in/courses/112106133/15

Heating Ventilation and Air Conditioning (HVAC)-I

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET553	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Learn the properties of air and methods of using psychometric charts.
- Understand the different methods of air conditioning systems.
- Know the Evaporative and Passive Cooling Systems.
- Impart the knowledge of different types of fans.
- Study the duct systems employed in air conditioning systems.

Syllabus

Module – I

Properties of Air: Moisture or Water Vapour, Relative Humidity, Absolute Humidity, Dew point, Water vapour Barrier in low temperature jobs, Water vapour content in air, its influence on load, effect of R H, Specific Humidity, Dry-Bulb and Wet bulb Temperature, Specific Volume, Sling Thermometer or Psychometer, Heat Content or Enthalpy of Air.

Methods of using Psychometric Charts: By- pass of Return Air, Evaporative Cooling.

08 Hours

Module – II

Air Conditioning Systems: Room Air Conditioners, Installation of Room Air Conditioners, Installations of Room Air Conditioners, Split Air Conditioners, Package Air Conditioners, Variable Refrigerant Flow (VRF) System, Central Air Conditioning Plants, Direct Expansions (DX) systems, Chilled Water Systems (Secondary Refrigerant Systems), Chilled Water Air- Washer Systems, Systems with Cooling Coils- Cooling Coil System, Reheat, Cooling with Humidification. **08 Hours**

Module – III

Evaporative and Passive Cooling Systems: Humidification Saturation or Air washer efficiency, High- Velocity Air washer, Humidification Plant for Textile Mills/ Textile Processing, Desert Coolers, De-humidification by Desiccants, Earth Air Tunnel System, Radiant Cooling Systems, Chilled Ceilings and Ceiling Induction Diffuser. **08 Hours**

Module – IV

Fans: Types of Fans, Centrifugal Fans- Forward Curved vanes, Backward Inclined and Backward Curved Fans, Aerofoil- Bladed Fans, Single Inlet and Double Inlet Centrifugal Fans, Axial Flow fans, Propeller Fan, Tube Axial fans, Vane Axial Fans, Fans of Special Designs, Roof ventilator, Tubular Centrifugal fans, Plug/Plenum Fans, Cross

Flow Fans, Fan Selection, Type of Fan System, Duct Installation, Airflow Configuration, Nature of Air to be Handled, Maximum Efficiency Point. **08 Hours**

Module – V

Duct System: Changes in direction, Change in Velocity due to contraction/ Expansion in Duct size, Elbows, Gain or Loss in Ducts, Aspect ratio, Duct design, Equal friction method, Velocity reduction Method, Static Regain Method, Duct Fabrication, Recommended Sheet Metal thickness, Recommended supports and hangers for horizontal Ducts, Leakage of Air from Ducts, factory Fabricated Ducting. **08 Hours**

Course Outcomes:

Upon the completion of the course, the student should be able to,

- Describe the different properties of Air and methods of using Psychometric Charts.
- Analyze the Air Conditioning Systems process.
- Demonstrate the various types of Evaporative and Passive Cooling Systems.
- Identify the types of Fans employed in Air- Conditioning systems.
- Design different types of Duct used in Air- Conditioning systems.

Text Books:

1. P N Ananthanarayanan,"Basic Refrigeration and Air- Conditioning", (Chapters 16, 15,19,20,21,23), Tata McGraw - Hill publication, 4th Edition, 2010, ISBN: 1-25- 906270-8.
2. C P Arora: "Refrigeration and Air conditioning", (Chapters 1-6,9), Tata McGraw - Hill publication, 2011, ISBN: 1-25-906270-8.

Reference Books:

1. Rex Miller, Mark R. Miller: "Air Conditioning and Refrigeration",(Chapters 1-6, 9,10,13,14), McGraw-Hill, 2nd Edition, 2012, ISBN: 0-07-146788-2.
2. Sapali S.N: "Refrigeration and Air Conditioning",(Chapters 1,2,3,4,5,),Prentice Hall India Learning Private Limited, 1st Edition, 2013, ISBN: 8120348729.
3. Ramesh Chandra Arora, "Refrigeration and Air Conditioning", (Chapters 1-5,9),Prentice Hall India Learning Private Limited, 1st Edition,2010,

ISBN: 8120339170.

4. Abhijit Chakrabarti: “A course in Refrigeration and Air- Conditioning”, (Chapters 1-6,9,12), PTHE Publishers, 2nd Edition,2011, ISBN: 8157000004

E-Resources:

1. http://nptel.ac.in/courses/112105128/
2. http://nptel.ac.in/courses/112105128/45

Metal Forming Process

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET561	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Learn the different methods of Metal working processes and effect of parameters.
- Understand the methods, load determination and various defects in the forging and extrusion process.
- Know the methods, variables, defects occurred for the rolling and sheet metal of various Products.
- Gain the knowledge of drawing process and expression for drawing force
- Impart the knowledge of powders, mixing, compaction and sintering of various components using powder metallurgy and methods of energy rate forming.

Syllabus

Module – I

Introduction and Concepts: Classificationof metal working processes, characteristics of wrought products, advantages and limitations of metal working processes.

Effects of parameters on metal working: Temperature, strain, strain rate, friction and lubrication, hydrostatic pressure in metalworking, Deformation zone geometry, workability of materials, Residual stresses in wrought products and flow stress.

08 Hours

Module – II

Forging: Classification of forging processes. Forging machines and equipments. Forging pressures and load in open die forging and closed die forging by slab analysis (No derivation), concepts of friction hill and factors affecting it. Die-design parameters. Forging defects, Simple problems.

Extrusion: Types of extrusion processes, Variables involved in extrusion

process, Metal flow pattern in extrusion, Defects in extruded products, Simple problem on extrusion forces(No derivation). **09 Hours**

Module – III

Rolling: Classification of Rolling processes. Types of rolling mills, Expression for rolling load. Roll separating force, power required in rolling, friction, friction hill, Maximum possible reduction. Defects in rolled products. Rolling variables, simple problems.

Sheet metal forming: Sheet metal operations and equipments, Classification of power presses. **07 Hours**

Module – IV

Drawing: Steps involved in wire drawing, Drawing die details, Optimal cone angle and dead zone formation, Redundant work and its estimation, Tube drawing processes, Expression for drawing force in wire drawing, Frictionless drawing of cylindrical rod, Simple problems. **08 Hours**

Module – V

High Energy Rate forming Methods: Principles, advantages, applications of Explosive forming, Electro hydraulic forming and Electromagnetic forming.

Powder metallurgy: Basic steps in Powder metallurgy, Production of metal powders, Blending metal powders, Compaction, Sintering and Finishing, Application, advantages and limitations of powder metallurgy. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to:

- Describe the necessity of forming process and effect of parameters during metal working.
- Describe the process, load required and possible reasons for the formation defects of the forged and extruded components.
- Analyze the rolling load calculations and reasons for the formation of defects in rolled products and parameters for the fabrication of various sheet metal components.
- Apply the Tube drawing processes and die designs.
- Explain the application of powder metallurgy and working of high energy rate forming methods.

Text Books:

1. George E. Dieter: “Mechanical metallurgy”, (Chapters 15-21), Tata McGraw - Hill publication, 4th Edition, 2010, ISBN: 0-07-084187.
2. Seropekal Pakajiam, Steven R Schimid: “Manufacturing Processes for Engineering materials”, (Chapters 3,5-8), Pearson education, 4th Edition, 2014, ISBN: 81-7808- 990-4, ISBN: 81-315-0245-6.

Reference Books:

1. Asok Kumar Mallik, Amitabha Ghosh: “Manufacturing Science”, (Chapters 1,2,6- 8), Affiliated East-west Press Pvt. Ltd., 2nd Edition, 2012, ISBN: 978-8156710633.
2. Dr. Sadhu Singh: “Theory of Plasticity and Metal Forming Processes”, (Chapters 2,3,8), Khanna Publishers, 1st Edition, 2008, ISBN: 978-8154090508.

E-Resources:

1. http://nptel.ac.in/courses/112106153/
2. http://nptel.ac.in/courses/112107145/4

Mechatronics

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET562	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Understand the basic concepts of Mechatronics systems and their applications.
- Learn the key elements of a measurement system and the basic performance specifications and models of a variety of analog and digital Mechatronics sensors.
- Study the characteristics and models of various electromechanical actuators. Semiconductor electronics as they apply to Mechatronics systems.
- Impart the e fundamental knowledge of microprocessor and microcontroller.
- Gain the knowledge of 8085 processor and 8085 programming.

Syllabus

Module – I

Introduction to Mechatronics: Introduction of Mechatronic systems, Evolution on Mechatronics, Measurement system, control systems, microprocessor based controllers, Mechatronics system design approach Automatic washing machine, automatic camera and Engine management system, Mechatronics approach and their associated problems. Examples and discussion on typical systems. **08 Hours**

Module – II

Transducers and Sensors: Introduction of Transducers, Classifications, Potentiometer, Capacitive Sensor, Eddy current proximity sensor, Hall effect sensor ,Temperature sensor, light sensors, selection of sensors, inputting data by switches, Strain gauge and Wheat Stone Bridge. **08 Hours**

Module – III

Electrical actuation systems: Electrical systems, Mechanical switches, solid state switches, DC and AC motors, stepper motors and their merits and demerits.

Signal conditioning: Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, digital signals Multiplexers, data acquisition, Introduction to Digital system processing pulse modulation. **08 Hours**

Module – IV

Introduction to Microprocessors: Evaluation of Microprocessor, Organization of Microprocessors (preliminary concepts), basic concepts of programming of microprocessors. Review of concepts- Boolean algebra, Logic Gates and gate networks, binary and decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real numbers
, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation. **08 Hours**

Module – V

Logic function, Data word representation: Basic elements of control systems 8085A processor architecture terminology such as CPU, memory and address, ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers.

Assembly Language Programming: 8085 programming, model instruction, classification, 8085 instruction set, Data format and storage, simple assembly programming. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to:

- Apply the basic mechanisms, mechanical components, actuators and sensors used in mechatronics systems and also with controllers of mechatronics systems.
- Describe the Measurement and signal handling technique in different sensors and transducers.
- Identify different motors; explain its working and their applications.
- Demonstrate the importance of data conversions, processing and storage in the microprocessor.
- Understand the fundamentals of microprocessor (intel 8085 and

4004) and application of microcontroller.

Text Books:

1. R.S. Ganokar, Wiley Eastern: “Microprocessor Architecture, programming and applications with 8085/8085A”, (Chapters 1-3,5,6,8-10), Penram International Publication, 6th Edition, 2013, ISBN: 9788187972884.
2. W. Bolton, Longman: “Mechatronics-Electronic control system in mechanical and electrical engineering”, (Chapters 1-3,5,6,8,9,15,21), Pearson Education, 6th Edition, 2017, ISBN: 9781292076683.

Reference Books:

1. Godfrey C. Canwerbolu: “Mechatronics Principles and applications”, (Chapters 1,3,5-10), Butterworth- Heinemann Publication, 1st Edition, 2005, ISBN: 978- 0750663793.
2. David. G. Aliciatore, Michael, B.Bihistand: “Introduction to Mechatronics and Measurement systems”, (Chapters 1,2,3,7,8,9,10), McGraw Hill, 3rd Edition, 2008, ISBN: 978-0-07-064814-2.

E-Resources:

1. http://nptel.ac.in/courses/112103174/11
2. https://ocw.mit.edu/courses/mechanical-engineering

Economics of Engineering

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MET563	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Study best alternative for right decision making in investment.
- Learn the worth of an asset by using different comparison methods (PW, FW, AEW).
- Understand the basics of estimation and costing.
- Know the concepts of financial statements.
- Impart factors which help to increase the profit in an organization through proper budgeting.

Syllabus

Module – I

Introduction: Engineering Decision-Makers, Engineering and Economics, Problem solving and Decision making, Intuition and Analysis, Tactics and Strategy. Engineering Economic Decision Maze. Law of demand and supply, Law of returns, Interest and Interest factors: Interest rate, Simple interest, Compound interest, Cash - flow diagrams, Personal loans and EMI Payment, Exercises and Discussion. **08 Hours**

Module – II

Present Worth Comparisons: Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives.

Future worth comparison: Pay-back comparison, Exercises, Discussions and problems.

Equivalent Annual Worth Comparisons: Equivalent Annual Worth Comparison methods, Situations for Equivalent Annual Worth Comparisons, Consideration of asset life, Comparison of assets with equal and unequal lives, Exercises Problems.

09 Hours

Module – III

Estimating and Costing: Components of costs such as Direct Material Costs, Direct Labor Costs, Fixed Over-Heads, and Factory cost, Administrative Over-Heads, First cost, Marginal cost, Selling price, Estimation for simple

components. **07 Hours**

Module – IV

Introduction, Scope of finance, Finance functions: Statements of Financial Information: Introduction, Source of financial information, Financial statements, Balance sheet, Profit and Loss account, relation between Balance sheet and Profit and Loss account. **08 Hours**

Module – V

Financial and Profit Planning: Introduction, Financial planning, Profit planning, Objectives of profit planning, Essentials of profit planning, Budget administration, type of budgets, preparation of budgets, advantages, problems and dangers of budgeting. Introduction to Bench Marking of Manufacturing Operations. **08 Hours**

Course Outcomes:

On completion of this course, the students are able to :

- Describe the types of interest and its factors and use them in EMI and loan calculations.
- Characterize different assets based on their Present, equivalent and future worth and judge the best alternative.
- Determine the quantity and selling price of engineering component.
- Analyze the financial concepts and prepare financial statements for the company.
- Demonstrate the concepts of financial and profit planning through suitable budgeting.

Text Books:

1. Riggs J.L: “Engineering Economy”,(Chapters 1-3,5-8,10,12), McGraw Hill, 4th Revised Edition, 2010, ISBN-13: 978-0079122483.
2. Thuesen H.G: “Engineering Economy”, (Chapters 1,2,5-7), Prentice Hall 9th Edition, 2012, ISBN-13: 978-0130281289.

Reference Books:

1. William G. Sullivan: “Engineering Economy”, (Chapters 1,3-5,8,9,11,13,14), Pearson, 14th Edition, 2010, ISBN-13: 978-8131534421.
2. Leland Blank: “Engineering Economy”, (Chapters 2,3,5,6,7,9,10), McGraw Hill Education (India) Private Limited, 7th Edition, 2012, ISBN-13: 978-1259027406.
3. E.Paul DeGarmo: “Engineering Economy”, (Chapters 1,3,5-9), Macmillan USA, 9th Edition, 2013, ISBN-13: 978-0023282713.

E-Resources:

1. http://nptel.ac.in/courses/112107209/

2. https://videos.najah.edu/node/2131

3. 

Energy Conversion Laboratory

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEL57	1:0:2:0	2	CIE:50SEE: 50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Learn the fundamentals of fuels and develop the ability to determine properties like
- Understand the flash and fire point, calorific value and viscosity of fuels through experimentation.
- Understand the concept of Valve and port timing diagrams and their significance in internal combustion engines.
- Develop the ability to conduct experiments to carryout performance testing of various
- Types of internal combustion engines and to evaluate various performance parameters.
- Study the performance of air compressor and air blower and to evaluate related performance parameters.

Syllabus

PART A

1. Determination of Flash point and Fire point of lubricating oil using Pensky apparatus.
2. Determination of Caloric value of solid, liquid and gaseous fuels.
3. Determination of Viscosity of a lubricating oil using Redwoods Viscometers.
4. Determination of Viscosity of a lubricating oil using Torsion Viscometers.
5. Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke).

PART B

1. Evaluation of Performance of 2-stroke air cooled, mechanically loaded petrol engine.
2. Evaluation of Performance of 2-stroke air cooled, electrically loaded petrol engine.
3. Evaluation of Performance of 4-stroke air cooled, electrically loaded petrol engine.
4. Morse test on a multi-cylinder engine.
5. Performance testing of 4-stroke diesel engine with heat balance analysis.

Course Outcomes:

Upon the completion of the course, the student should be able to,

- Fundamental properties of fuels and experimental methods to determine the values.
- Importance and significance of valve and port timing diagrams in four stroke and two stroke engines.
- Experimental procedure to evaluate various performance parameters of different types of I C engines.
- Performance of Air compressor and blower and to assess various performance parameters.

Conducting classes: Classes may be conducted in one slot per week, of 3 hours (Instruction 1 Hr. + Conduction and Calculation 2 Hr.)

Scheme of Evaluation:

ONE question from part - A:	20 Marks
ONE question from part - B:	20 Marks
Viva-voce:	10 Marks
TOTAL:	**50 Marks**

Robotics Laboratory

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18MEL58	1:0:2:0	2	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the different robotic configurations and their subsystems.
- Explore the broad scope of robotic applications.
- Analyze the basic components and building blocks of robots.
- Determine maximum and minimum position of links.
- Learn different robot language and programming methods of robot.

List of Experiments:

1. Experiment on different types of robots based on configuration and application.
2. Determination of degrees of freedom for robotic arm.
3. Determination of gripping force and actuating force for mechanical gripper.
4. Determination of maximum and minimum position of links.
5. Simulation of different robot motion based on application
6. Estimation of accuracy, repeatability and resolution.
7. Experiment on different actuators (electric, hydraulic and pneumatic types) and sensors used in developing robot.
8. Execute embedded C program using AVR Studio software.
9. Robot programming: Using Teach Pendent and Offline programming to perform pick and place, Stacking of objects, 2 programs.
10. Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.

Upon the completion of the course, the student should be able to,

- Ability to visualize the configurations of various types of robots.
- Understanding the components of robots like arms, linkages, drive systems and end effectors.
- Ability to measure the performance of robots.
- Develop new robot based on application.
- Enhance programming skills by writing programs in different software. **Conducting classes:** Classes may be conducted in one slot per week, of 3 hours (Instruction 1 Hr. + Conduction and Calculation 2 Hr.)

Scheme of Evaluation:

Group Experiment:	25 Marks
Individual Experiment:	15 Marks
Viva-voce:	10 Marks
Total:	**50 Marks**

General Aptitude

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEH59	2:0:0:0	2	CIE:50 SEE:50	3 Hours	HSS

Course Objectives:

This course will enable students to :

- Understand different types of Numerical / Arithmetical problems.
- Understand the different Data interpretation problems.

Syllabus

Module – I

Numerical Ability-I: Numbers, HCF and LCM of numbers, Decimal Fractions, Average, Problems on Numbers, Problems on Ages. **06 Hours**

Module – II

Numerical Ability-II: Percentage, Profit and Loss, Ratio and Proportion, Partnership, Chain Rule, Time and Work. **05 Hours**

Module – III

Numerical Ability-III: Pipes and Cistern, Time and Distance, Problems on Trains, Alligation or Mixture, Simple Interest, Compound Interest. **05 Hours**

Module – IV

Numerical Ability-IV: Races and Games of Skill, Calender, Clocks, Permutations and Combinations, Probability, Odd man out and Series. **05 Hours**

Module-V

Data Interpretation: Tabulation, Bar Graphs, Pie Charts, Line Graphs. **05 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Solve and analyze different types of Numerical / Arithmetical problems.
- Solve and analyze different Data interpretation problems.

Text Books:

1. R S Aggarwal: "Quantitative Aptitude for competitive examinations", (Chapters 1-3,6-8,10-18,20-22,26-28,30,31,35-39), S. Chand Publishing,

New Delhi, 2014, ISBN-13: 978-81-219-2498-6.

Machine Design-II

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET61	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the concepts of different stresses in curved beams and closed chains.
- Impart the knowledge of springs, fluctuating stress and its effects on springs.
- Realize the importance of gears, steps involved in design of spur gears and analyze different strength parameters in spur gear.
- Study the steps involved in design of helical and bevel gears and analyze different strength parameters in helical and bevel gears.
- Learn the need of lubrication and mechanisms and friction reduction in journal bearings.

Syllabus

Module – I

Curved Beams: Difference between straight and curved beams, Stresses in curved beams of standard cross sections used in crane hook, punching Presses and clamps, stresses in closed rings and links. **08 Hours**

Module – II

Springs: Types of springs, Functions and applications of springs, Spring materials, Surge in springs, end styles, Terminology of Helical Springs, Stresses in Helical coil springs of circular and non-circular cross sections. Expression for strain energy stored in springs, design considerations, Belleville springs, springs under fluctuating loads, Leaf Springs: Stresses in leaf springs. Equalized stresses (Nipping). **09 Hours**

Module – III

Spur gears: Introduction, Classification of Gears, advantages and disadvantages of gears over belt drives, Standard systems of gear tooth, gear materials, gear terminology, selection of type of gears, Types of failure,

design requirements, design analysis, Beam strength equation by Lewis , design procedure, design as recommended by AGMA. Gear Lubrication. **08 Hours**

Module – IV

Helical Gears: Terminology of Helical Gears, Virtual number of teeth, Tooth proportions, Force analysis, Beam strength, Effective Load on gear tooth, design procedure.

Bevel Gears: Terminology of Bevel Gears, Force Analysis, Beam strength, effective load on gear tooth, design procedure, Design as recommended by AGMA. **08 Hours**

Module – V

Lubrication and Bearings: Types of wear, Types of lubricants and their properties, Selection of Lubricants, classification of bearings, Mechanisms of Lubrication in bearings, Bearing characteristic number and bearing modulus, sommerfeld number, petroff's Equation, coefficient of friction, minimum oil film thickness, Heat Generated, Heat dissipated, Bearing Materials, Examples of journal bearing. **09 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Demonstrate the fundamentals of stress analysis, different stress in curved beams
- Make proper assumptions with respect to material, size, static and dynamic loads for springs.
- Design of spur gears for different power transmission ratio and to find BHN.
- Analyze helical and bevel gears based on strength, dynamic and wear loads.
- Apply the knowledge to reduce friction using different lubrication mechanisms and forces acting on bearings.

Design Data Hand Books:

1. K. Lingaiah: "Design Data Hand Book", McGraw Hill, 2nd Edition, 2003.

2. K. Mahadevan, Balaveera Reddy: “Design Data Hand Book”, CBS Publication.

3. H.G. Patil Machine: “Design Data Hand Book”, Shri Shashi Prakashan, Belgaum.

Text Books:

1. Joseph E Shigley, Charles R. Mischke, “Mechanical Engineering Design”, (Chapterss- 1,2,5,7), Tata McGraw Hill Publishing Company Ltd., New Delhi, 8th Edition, 2008, ISBN: 978-0-07-066861-4.

2. V.B. Bhandari, “Design of Machine Elements”, (Chapters- 1,2,4,5,6,7,8,9), Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2013, ISBN: 978-0-07-068179-8.

Reference Books:

1. Robert L. Norton: “Machine Design”, (Chapters-1,3,4,5,6,9,14), Pearson Education Asia, 2nd Edition, 2000, ISBN: 978-0-07-014480-4.

2. M.F.Spotts, T.E. Shoup, L.E. Hornberger, S.R. Jayram, C.V. Venkatesh: “Design of Machine Elements”(Chapters- 1,2,5,7), Pearson Education, 8th Edition 2006 ISBN: 81-7758-421-9.

3. Sharma, Purohit C.S, Kamalesh: “Design of Machine Elements” (Chapters 1,2,5,6) Pearson publications, New Delhi, 2nd Edition, 2003, ISBN: 81-203-1955-9.

E-Resources:

1. http://nptel.ac.in/courses/112106137/

2. http://nptel.ac.in/syllabus/112106138/

3. 

Computer Integrated Manufacturing (IC)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEI62	3:0:2:0	4	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the basic concepts of computer integrated Manufacturing.
- Study the devices used in automated assembly systems and also application of computer in planning process.
- Know the concept of Flexible Manufacturing Systems and also to study how the inspection system is automated.
- Impart working principle of computer numerical control machines and also able to write N.C part programming for milling and turning centre.
- Gain basic concept of industrial robot and also to know different methods and languages of robot programming.

Syllabus

Module – I

Computer Integrated Manufacturing System: Introduction, Automation definition, Types of automation, CIM, processing in manufacturing, production concepts, Mathematical Models:-manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, work-in-process, WIP ratio, TIP ratio, without numerical problems. **High volume production system:** Introduction, Automated flow line symbols, Objectives, Work part transport-continuous, Intermittent, Synchronous, Pallet fixtures, Transfer Mechanism:- Linear-Walking beam, roller chain drive, Rotary- Rack and pinion, Ratchet and Pawl, Geneva wheel, Buffer storage, control function- sequence, safety, quality, Automation for machining operation. **08 Hours**

Module – II

Automated assembly systems: Design for automated assembly systems, types of automated assembly systems, parts feeding devices- Elements of parts delivery system-hopper, part feeder, selectors, feedback, escapement and placement devices, analysis of multistation, assembly machine with numerical problems, analysis of single station assembly with numerical

problems, Automated Guided Vehicle System: Introduction, Vehicle guidance and routing, system management.

Computerized manufacturing planning system: Introduction, computer aided process planning, Retrieval type of process planning, Generative type of process planning, material requirement planning, Fundamental concepts of MRP, Capacity planning. **10 Hours**

Module – III

Group Technology and Flexible Manufacturing Systems: Part families, Parts classification and coding, production flow analysis, machine cell design, Benefits of

Group technology, FMS workstation, Material handling and storage system, computer control systems, planning the FMS.

Automated Inspection and Testing: Inspection and testing, SQC, Automated inspection principles and methods, coordinate measuring machines, other contact inspection methods, optical inspection methods, non-contact inspection methods.

09 Hours

Module – IV

Computer Controls in NC:CNC components, Functions of CNC control in Machines Tools, G-codes and M-codes, Tool length compensation, cutter compensation, canned cycle for drilling, threading, turning, Direct Numerical Control (DNC): Configuration of DNC system, Functions of DNC, Communication between DNC computer and MCU, Advantages and disadvantages of CNC, Advantages of DNC.

NC part programming: Introduction to CNC machining center and CNC turning center, part programming, Fundamental steps involved in development of part programming for milling and turning. **10 Hours**

Module – V

Machine vision, system: Acquisition of image, analysis and applications. Different camera devices, A/D conversion technique. **08 Hours**

List of Experiments: CNC part programming using CAM packages

Simulation of:

1. Turning
2. Drilling
3. Milling
4. 3 typical simulations to be carried out using simulation packages like Master
   – CAM, or any equivalent software.

Course Outcomes:

On completion of this course, students will be able to :

- Describe Automation and CIM and able to solve production related problems.
- Analyze automated assembly line and solve single station assembly related problems.
- Demonstrate the concept of Group Technology and working of coordinate measuring machine.
- Write CNC programme and steps involved in development of part programming.
- Demonstrate the machine vision and different camera devices

Text Books:

1. M.P.Groover: "Automation, Production system and Computer Integrated manufacturing", (Chapters 1,6,7,10,14,16,17), Prentice Hall India Publications, 2nd Edition, 2007, ISBN: 978-81-317-0227-8.
2. S. Kant Vajpayee: "Principles of Computer Integrated Manufacturing", (Chapters 1,2,7,8,10), Prentice Hall India Publications, 1st Edition, 2007, ISBN: 978-81-203-1476-4.

Reference Books:

1. Mikell P. Groover, Emory W. Zimmers," Computer Aided Design and Computer Aided Manufacturing", (Chapters 7,8,10-13,17,19,20), Prentice Hall India, publications, 2nd Edition, 2006, ISBN: 978-81-203-0402-4.
2. P. Radhakrishnan, S. Subramanyam and V.Raju: "CAD/CAM/CIM" (Chapters 2,13,14,19), New Age International (P) Limited Publishers, 3rd Edition, 2008, ISBN: 978-81-224-2236-5.

E-Resources:

1. http://nptel.ac.in/courses/112105211/

2. http://nptel.ac.in/courses/112103174/

3. 

Finite Element Methods (IC)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEI63	3:0:2:0	4	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Impart knowledge on the concept of finite element methods for analysis of structures.
- Study the finite element analysis of bars.
- Educate the students regarding the finite element formulation of 2-D problems.
- Expose the students to Finite element analysis of trusses.
- Learn the finite element analysis of beams.

Syllabus

Module – I

Introduction to Finite Element Methods (FEM): Equilibrium equations in elasticity subjected to body force, traction forces and point loads, plane stress and plane strains problems. Engineering Analysis,definition and history of FEM, basic steps in FEM to solve mechanical problems. Discretization, types of elements based on geometry, Node numbering Scheme, concept of half band width, applications, advantages and limitations of FEM. **10 Hours**

Module – II

Analysis of Bars: Shape function and its properties, Shape function for bar element, Stiffness matrix formulation of bar element, Uniform and stepped cross sectional bars. Solutions of uniform bars and stepped bars for displacements, stresses and reactions by using elimination approach and penalty approach. Gauss elimination approach. **10 Hours**

Module – III

Interpolation Models: Interpolation polynomials for Linear, quadratic and cubic elements. Simplex, Complex and Multiplex elements. Convergence requirements, Compatibility condition, Coordinate Systems, PASCAL's triangle. Shape functions of three-nodedtriangular element, and four-noded quadrilateral element. Serendipity and Lagrange family Elements, Higher order elements, iso-parametric, Sub- parametric and Super parametric

elements. **10 Hours**

Module – IV

Analysis of Trusses: Introduction to Trusses**,** assumptions made in analysis of Trusses, Derivation of stiffness matrix, Strain matrix, Stress matrix. Solutions of Truss element for nodal displacements, stresses and support reactions. **09 Hours**

Module – V

Analysis of Beams: Introduction, types of beam. Hermite shape functions for beam element. Derivation of stiffness matrix. Numerical problems of beams carrying concentrated, uniform distributed loads. **09 Hours**

List of Experiments:

1. Introduction to FEM software and Modeling of 1-D, 2-D and 3-D model.
2. Analysis of uniform and stepped cross sectional Bars.
3. Analysis of stress on a flat plate with a hole at its centre.
4. Analysis of 2-D Truss structure with point loads only.
5. Analysis of Cantilever Beams with Uniform Distributed Loads, Uniform Varying Load, concentrated point loads and moments.
6. Analysis of Simply Supported Beams with Uniform Distributed Loads, Uniform Varying Load, concentrated point loads and moments.

Course Outcomes:

On completion of this course, students will be able to :

- Apply the basic concepts of finite element method and carryout the analysis.
- Realize the importance of finite element analysis of bars.
- Develop the skills required to use commercial FEA software in 2-D analysis.
- Learn the basics of finite element analysis of trusses utilized to solve engineering problems.
- Solve the finite element analysis of beams.

Text Books:

1. Daryl L Logan: “A first course in the Finite element method”, (Chapters 1-4,6-8), CCL Engineering Publisher, 2012, 5th Edition, ISBN 13: 978-0495668251.
2. T. R. Chandrupatla, A. D. Belegundu: “Introduction to Finite Elements in Engineering”, (Chapters 1-6,8), Pearson Publisher, 2011, 4th Edition, ISBN-13: 978- 0132162746.
3. S.S. Rao: “Finite Elements Method in Engineering”, (Chapters 1-4,8,9), Elsevier,
   5th Edition, 2010, ISBN: 978-1856176613.

Reference Books:

1. Lakshminarayana H.V: “Finite Elements Analysis - Procedures in Engineering”, (Chapters 1-3, 6), Universities Press (India) Pvt. Ltd., 2004, ISBN: 9788173714764.
2. P. Seshu: “Textbook of Finite Element Analysis”, (Chapters 2-5), PHI Learning Pvt. limited, 2013, ISBN: 978-8120323175.

E-Resources:

1. http://nptel.ac.in/courses/112104116/
2. http://nptel.ac.in/courses/112106135/
3.

Non – Conventional Machining

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET641	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Understand the parameters involved in different NTM processes and working process parameters of USM and AJM.
- Know the working and process parameters of electro chemical machining and chemical machining.
- Learn the methods, Process characteristics, working of EDM.
- Impart the knowledge elements related to PAM and LBM.
- Study the equipment, working, applications of EBMand WJM processes.

Syllabus

Module – I

Introduction: History, Classification, comparison between conventional and Non- conventional machining process selection.

Ultrasonic Machining: Introduction ,Equipment, Tool material and tool size, Abrasive slurry, cutting tool system design, Effect of parameter: effect of amplitude, frequency, Effect of vibration, abrasive diameter, Effect of applied static load, slurry, tool and work material, USM process characteristics: MRR, tool wear, accuracy, surface finish, Application, advantages and disadvantages of USM.

Abrasive Jet Machining: Introduction, Equipment, Variables in AJM, Carrier gas, types of abrasive, size of abrasive grain, Velocity of the abrasive jet, mean number, abrasive particles/unit volume of carrier gas, Work material, stand-off distance, nozzle design, shape of cut, Process characteristics: MRR, nozzle wear, accuracy , surface finish, Applications, advantages and disadvantages of AJM. **08 Hours**

Module – II

Electro Chemical Machining: Introduction, study of ECM machine,

elements of ECM, Cathodetool, Anode work piece, source of DC power, Electrolyte, chemistry of process, ECM process characteristics,-MRR, accuracy, surface finish, ECM tooling:

ECM tooling technique and Example, Tool and insulation materials, tool size, electrolyte flow arrangement, Handling of slug, Economics of ECM, applications such as electrochemical turning, Electrochemical grinding, Electrochemical honing, deburring, advantages, limitations.

Chemical Machining: Introduction, elements of process, Chemical blanking process, preparation of work piece, Preparation of masters, masking with photo resists, etching for blanking, Accuracy ,applications of chemical blanking, chemical milling, Process steps-masking, etching, process characteristics of CHM, MRR, accuracy, surface finish, hydrogen embrittlement, Advantages and application of CHM. **08 Hours**

Module – III

Electro Discharge Machining: Introduction, Mechanism of material removal, Dielectric fluid, Spark generator, EDM tools, electrode feed control, electrode manufacture, Electrode wear, EDM tool design, choice of machining operation, Electrode material selection, under sizing, length of electrode, machining time, Flushing, pressure flushing, suction flushing, Side flushing, pulsed flushing, EDM process characteristics: MRR, accuracy, surface finish, HAZ, machine tool selection, Application, EDM accessories/ applications, Electric discharge grinding, traveling wire EDM. **08 Hours**

Module – IV

Plasma Arc Machining: Introduction, equipment, non thermal generation of plasma, Selection of gas, Mechanism of metal removal, PAM parameter, Process characteristics, safety precautions, applications, advantages and limitations.

Laser Beam Machining: Introduction, equipment of LBM, Mechanism of metal removal LBM parameters, process characteristics, Advantages, limitations. **08 Hours**

Module – V

Electron Beam Machining: Principles, Equipment, operations, Applications, advantages, limitations of EBM.

Water Jet Machining: Principle, equipment, operation, Applications, advantages and limitations of WJM. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Describe the importance of NTM methods and USM and AJM parameters.
- Demonstrate different parameters and working of electro chemical machining and chemical machining.
- Apply the application of EDM process.
- Select an appropriate NTM process for the machining of the components and application of PAM and LBM.
- Correlate specific applications of various NTM methods and Analyze the EBM and WJM principles.

Text Books:

1. P C Pandey, Shan: "Modern machining process",(Chapters 1-4), Tata McGraw - Hill publication, 1st Edition, 2000, ISBN-13: 978-0-07-096553-9.

2. HMT: "Production Technology", (Chapterss 14.1,14.2,14.3,14.4,14.5,14.6,14.7,1 4.8),Tata McGraw Hill , 1stEdition, 2006, ISBN: 0-07-096443-2.

Reference Books:

1. P.K.Mishra: "Non-Conventional Machining", (Chapters 1-12), Narosa Publishing House,1st Edition, 2007, ISBN: 978-8173191923.

2. Vijay K Jain: "Advanced Machining Processes", (Chapters 1-5,16,17), Allied Publishers Pvt. Ltd., 4th Edition, 2009, ISBN: 81-7764-294-4.

E-Resources:

http://nptel.ac.in/courses/112105126/36

Turbo machines

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET642	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Understand the comparison of positive displacement turbo machine and energy transfer in turbomachine.
- Know general analysis of utilization factor and axial flow turbomachines.
- Develop design of hydraulic turbines, steam turbines.
- Impart knowledge of centrifugal pumps and stage efficiency, reheat factor and preheat factors in turbines and pumps.
- Study working of thermodynamic of fluid flows, design of centrifugal and axial compressors.

Syllabus

Module – I

Introduction: Definition of a turbomachine, parts of a turbomachine, Comparison with positive displacement machine; Classification; Dimensionless parameters and their physical significance; Effect of Reynolds number; Specific speed; Illustrative examples on dimensional analysis and model studies.

Energy Transfer in Turbo Machine: Euler Turbine equation; Alternate form of Euler turbine Equation, components of energy transfer; Degree of reaction. **08 Hours**

Module – II

General Analysis of Turbines: Utilization factor, Vane efficiency, Relation between utilization factor and degree of reaction, condition for maximum utilization factor – optimum blade speed ratio for different types of turbines.

General analysis of centrifugal pumps and compressors: General analysis of axial flow compressors and pumps – general expression for degree of reaction, velocity triangles for different values of degree of reaction. Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, Theoretical head – capacity

relationship. **08 Hours**

Module – III

Hydraulic Turbines: Classification, Pelton Turbine-velocity triangles, Design parameters, turbine efficiency, volumetric efficiency. Francis turbine-velocity triangles, runner shapes for different blade speeds, Design of Francis turbine, Functions of a Draft tube, types of draft tubes, Kaplan and Propeller turbines – Velocity triangles and design parameters. Characteristic curves for hydraulic Turbines. **08 Hours**

Module – IV

Steam Turbines: Introduction to steam nozzles and optimum pressure ratio. Impulse Staging and need for compounding, Velocity and pressure compounding, velocity triangle, condition for maximum utilization factor for multistage turbine with equiangular blades, Effects of Blade and Nozzle losses, Reaction staging.

Centrifugal Pumps: Definition of terms used in the design of centrifugal pumps like manometric head, suction head, delivery head, manometric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency, multistage centrifugal pumps design procedure. **08 Hours**

Module – V

Thermodynamics of Fluid Flow and Thermodynamic Analysis of Compression and Expansion Processes: Stagnation and static properties and their relations, Compression process – overall isentropic efficiency of compression, State efficiency, Comparison and relation between overall efficiency and stage efficiency, Polytrophic efficiency, Preheat factor, Expansion process – Overall isentropic efficiency for a turbine, Stage efficiency for a turbine, Comparison and relation between stage efficiency and overall efficiency for expansion process, polytropic efficiency of expansion, Reheat factor for expansion process.

Centrifugal Compressors and Axial Flow Compressors: Centrifugal compressors, Main parts and principle of operation power input factor, pre whirl vanes, surging and checking phenomenon. Axial Flow Compressors: Construction and working principle, work done factor (No Numerical Problems). **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Describe working and various energy transfer processes in turbo-machines.
- Evaluate the fluid flow in steam and hydraulic turbines.
- Apply the working of pelton and francis turbine.
- Demonstrate the working of steam turbines, centrifugal pumps.
- Analyze thermodynamic analysis of fluid flow and centrifugal compressors.

Text Books:

1. V.Kadambi, Manohar Prasad: "An Introduction to energy conversion, Volume III – Turbo machinery", (Chapters 1-6,9), New Age International Publishers (P) Ltd., 2nd Edition, 2011, ISBN: 978-8122431896.
2. G.Gopalakrishnan, D.Prithviraj: "A Treatise on Turbo Machines", (Chapters 1-6, 9-11), Scitech Publications (India) Pvt. Limited, 2nd Edition, 2010, ISBN: 978- 8187328988.
3. Dr. Niranjan Murthy, Dr. R.K.Hegde: "Turbomachines", (Chapters 1-12), Sapna Publications, 2nd Edition, 2013, ISBN: 978812809228.

Reference Books:

1. H.Cohen, GFC Rogers, HIH Saravanamuttoo: "Gas Turbine Theory", (Chapters 1-4), Thomson Press (India) Ltd., 4th Edition, 1998, ISBN: 81-297-0486-2.
2. S. M. Yahya: "Turbines, Compressors and Fans", (Chapters 1-5), Tata-McGraw Hill Co, 2nd Edition, 2010, ISBN-13: 978007451219912.

E-Resources:

1. http://nptel.ac.in/courses/Webcourse-contents/IIT-KANPUR/machine/ui/ Course_home-1.htm
2. http://nptel.ac.in/courses/112106200/

Heating Ventilation and Air Conditioning (HVAC)-II

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET643	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Understand of Clean rooms and its working.
- Learn the concept of thermal insulation.
- Know the different types of Insulating Materials.
- Impart the knowledge of Heat Load.
- Study the equipment selection in air conditioning systems.

Syllabus

Module – I

Clean Rooms: Classifications of Clean rooms, Airflow pattern in Clean Rooms, Non- unidirectional airflow Pattern, Unidirectional airflow Pattern, Construction, Air Filters, and Operational Guidelines. **08 Hours**

Module – II

Thermal Insulations: Thermal Conductivity (K), R-value (insulation), U-value, Degree of Insulation Needed, Surface Temperature in Relation to the Heat Transfer, Insulation Ageing, Vapour Barrier. **08 Hours**

Module – III

Selection of Insulating Materials: Thermal Mass in Buildings, Where to Insulate, Location of Structural Insulation, Insulating Ducts and pipes, EPDM Elastomeric Insulation, Reflective Insulation, Fibreglass, Polystyrene, Expanded polystyrene, Method of Laying, chilled-Water Piping/Refrigerant Suction Line Cold storages,

08 Hours

Module – IV

Heat Load: Apparatus Dew Point (ADP), Heat- Load Estimation, Heat- Load Estimation Form, Effective Room Sensible Heat Gain (ERSH), Effective Room Latent Heat Gain (ERLH). **08 Hours**

Module – V

Equipment Selection: Chiller Selection, DX Chiller Selection, Flooded Chiller, Selecting Other Equipments, Compressor Selection, Condenser Selection, Water-

Cooled Condenser Selection**,** Evaporator Condenser, Air-Cooled Condenser, Selection of Thermostatic-Expansion Valve (TEV), Determination of Pressure Drop across a TEV, Sizing of Refrigeration Pipes, System Balance. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Learn and understand the concept of clean rooms and operational guidelines.
- Describe the need of thermal insulations in air conditioning systems.
- Identify the various types of insulating material used in air-conditioning systems.
- Analyze the loads in air- conditioning systems.
- Apply equipment selection used in air- conditioning systems.

Text Books:

1. P N Ananthanarayanan: "Basic Refrigeration and Air- Conditioning", (Chapters 16,17,19-21,23), Tata McGraw - Hill publication, 4th Edition, ISBN: 1-25- 906270-8.
2. James E. Brumbaugh: "Audel HVAC Fundamentals, Volume 1: Heating Systems, Furnaces and Boilers", (Chapters 1-9), Wiley Publishing, 4th Edition, ISBN: 978-0- 7645-4206-0.

Reference Books:

1. Rex Miller, Mark R. Miller: "Air Conditioning and Refrigeration", (Chapters 1,2,6- 9), McGraw-Hill, 1st Edition, 2006, ISBN: 978-0071467889.
2. Robert Mcdowall: "Fundamentals of HVAC Systems", (Chapters 1,2,6-8), Academic Press, Elsevier Science, SI Edition, 2006, ISBN: 978-0123739988.

E-Resources:

1. http://nptel.ac.in/courses/112105129/35
2. 

Refrigeration and Air Conditioning

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET651	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Understand Methods of Refrigeration and Gas Cycle Refrigeration
- Develop skills in Refrigerants and its types and frictional, dynamic losses in air conditioning systems.
- Study the working principle of vapour compression refrigeration system.
- Impart the knowledge of vapour absorption refrigeration system and its components.
- Know basic concept of airconditioning design and its load calculations.

Syllabus

Module – I

Methods of Refrigeration: Ice refrigeration, evaporative refrigeration, air refrigeration, Vapour refrigeration, dry ice refrigeration, thermo electric refrigeration, pulse tube refrigeration, thermo acoustic refrigeration.

Gas Cycle Refrigeration: Introduction, reverse Carnot cycle, Bell Coleman Cycle, advantages anddisadvantages of gas refrigeration system. Applications to aircraft refrigeration, Analysis of gas refrigeration and numericals. **08 Hours**

Module – II

Refrigerants: Types of Refrigerants, Comparative study of Ethane and Methane derivatives, selection of Refrigerants, Requirements of Refrigerants Effects of lubricants in Refrigerants, substitutes of CFC Refrigerants.

Transmission And Distribution of Air: Room Air Distribution, Friction loss in ducts, dynamic losses in ducts, Air flow through simple Duct system, Duct design. **08 Hours**

Module – III

Equipments Used In Vapour Compression Refrigeration System: Compressors: Principle, types of compressors, capacity control. Condensers: Types and construction, Expansion devices: Types- Automatic expansion valve, Thermostatic expansion valves, capillary tube. Sizing Evaporator: Types and construction. **08**

Hours

Module – IV

Vapour Absorption System: Common refrigerant absorbent combinations, Binary mixtures, Ammonia Water Absorption system, Actual Vapour absorption cycle and its representation on enthalpy. Composition diagram, calculations. Triple fluid Vapour absorption refrigeration system. Water – Lithium Bromide absorption chiller.

08 Hours

Design Conditions: Outside design conditions, choice of inside conditions, comfort chart. Choice of supply design condition.

Load Calculations and Applied Psychometrics: Internal heat gains, system heat gains, break up of ventilation load and effective sensible heat factor, Bypass factor, cooling load estimate. Psychometric calculations for cooling. Selection of Air conditioning apparatus for cooling and dehumidification, evaporative cooling. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Describe the methods of Refrigeration and Gas cycles.
- Analyze the different types of refrigerants and Transmission and Distribution of Air.
- Concept of Vapour Compression Refrigeration System.
- Expose knowledge of working of Vapour Absorption Refrigeration System.
- Analyze the Design Conditions, Load Calculations and properties and process of Psychometrics.

Text Books:

1. C.P.Arora: “Refrigeration and Air-Conditioning”, (Chapters 2-4,6,7,12,14,16, 17,21,23), Tata McGraw Hill Publication, 2nd Edition, 2001, ISBN-13: 978-0-07- 463010-5.
2. Dossat: “Principles of Refrigeration”, (Chapters 5-11,14,16,17), Pearson Publication, 4th Edition, 2006, ISBN: 978-81-7758-881-1.

Reference Books:

1. Shan K Wang, ZalmanLawan, Paul Norton: “Air conditioning and Refrigeration Engineering”, (Chapters 1-6,8,11,12,14,17), CRC Press, 2nd Edition, ISBN: 0-8493- 0057-6.

2. Stephen M. Elonka, Quaid W. Minich: “Standard Refrigeration and Air-Conditioning”, (Chapters 1-6,8), Tata McGraw Hill Publication, 2nd Edition, 1982, ISBN: 0970992835.

E-Resources:

1. http://nptel.ac.in/courses/112105128/

2. http://nptel.ac.in/courses/Webcourse-contents/IIT%20Kharagpur/Ref%20and%20Air%20Cond/New_index1.html

Operations Research

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET652	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Understand the fundamentals of OR, formulation of linear programming problems.
- Study the basic knowledge in various types of transportation and assignment problems.
- Impart the fundamental concepts related to PERT-CPM techniques.
- Learn the Game theory, solution by graphical method and dominance rule.
- Know the various types of sequencing methods.

Syllabus

Module – I

Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, Formulation of LPP, Graphical solutions. linear programming (LP) problems-The Simplex Method, Big M method. **08 Hours**

Module – II

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases. **08 Hours**

Module – III

Pert-CPM Techniques: Introduction, network construction - rules,

Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project. **08**

Hoursodule – IV

Game Theory: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games.

Queing Theory: Queing systems and their characteristics, M/M/1 Queing systems, problems. **08**

Hours

Module – V

Sequencing: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines, Sequencing 2 jobs on 'm' machines using graphical method. **08**

Hours

Course Outcomes:

On completion of this course, students will be able to :

- Describe the fundamental concepts of OR and formulate the linear programming problems.
- Solve various types of problems related to Transportation and Assignment.
- Construct the network, find the expected duration and probability of completing a project.
- Formulate the games and find the solution for various types of games.
- Improve decision making and solve various types of sequencing problems.

Text Books:

1. P K Gupta, D S Hira: "Operations Research", (Chapters 1-5,9,10,14), Chand Publications, 5th Edition, 2011, ISBN: 81-219-0281-9.
2. Taha H A: "Operations Research", (Chapters 1-3,5,6,17), Pearson Education, 7th Edition, 2004, ISBN: 81-203-2235-5.

Reference Books:

1. Paneerselvam: "Operations Research", (Chapters 1-4,9,10,12), PHI Publications,
2nd Edition, 2011, ISBN: 978-81-203-2928-7.

2. A M Natarajan, P Balasubramani: "Operations Research", (Chapters 1,2,4,5,7,8,12), Pearson Education, 3rd Edition, 209, ISBN: 978-81-317-0000-6.
3. S.D. Sharma: "Operations Research" (Chapters 1,3,5,11,12,19,23,24), Kedarnath Ramnath Publications, 17th Edition, 2014, ISBN: 93-80803-389.

E-Resources:

1. http://nptel.ac.in/courses/112106134/1

Wind Energy Engineering

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET653	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Learn the basics about wind and energy transfer.
- Gain the knowledge for different properties of wind.
- Understand the Aerodynamics of wind turbine blades.
- Study the basics about Wind measurement and electricity and generators.
- Impart the knowledge of wind power generation and its impact on environmental wind power projects.

Syllabus

Module – I

Basics of wind energy and power: Introduction, kinetic energy of wind, sensitivity of power to rotor radius and wind speed, basic concepts, equations, conservation of mass, energy, momentum, wind versus water. **08 Hours**

Module – II

Properties of wind: Introduction, wind generation, statistical distribution of wind speed, mean and mode of Weibull distribution for wind speed, power density, wind classes, wind shear, density of air as a function of elevation, density of air as a function of humidity. **08 Hours**

Module – III

Aerodynamics of wind turbine blades: Introduction, aerofoils, relative velocity of wind, rotor disc theory, lift force, equal transit time fallacy rotor fluid flow, circulation and vortices, real fluids, flow of fluid over aerofoil, effect of Reynolds number on lift and drag coefficients, drag based turbines, variable speed turbines, vertical axis wind turbines, power curves. **08 Hours**

Module – IV

Wind measurement: Introduction, definition of wind speed, configurations to measure wind, designing a wind measurement campaign, installation of met towers, data management, data processing, computed quantities.

Basics of electricity and generators: introduction, basic principles of electromagnetism, basic principles of AC, basic principles of electrical machines, synchronous generators, asynchronous generators. **08 Hours**

Module – V

Environmental impact of wind projects: Introduction, framework for analysing environment impact: context of environmental impact, temporal and spatial scale, cumulative effects, comparision of wind versus fossil fuel based electricity production, impact of wind farms on wild life, noise from wind turbines, shadow flicker, aesthetic impact, hazard to aviation, electromagnetic interference. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Describe the necessity of wind energy concepts and energy transfer equations.
- Apply the effect of different properties like speed, power density wind shear, elevation and humidity on wind power generation.
- Analyze the effect of aerodynamics of wind turbine blade.
- Demonstrate the wind energy measurement concepts and electricity generators
- Analysis of environmental impact of wind energy projects..

Text Books:

1. Pramodjain: "Wind energy engineering",(Chapters 2-6,10,12), Tata McGraw - Hill Publication, 2nd Edition,2010, ISBN: 978-0-07-171477-8.
2. J F Manwell, J G Mcgowan, A L Rogers: "Wind energy explained", (Chapters 1-3,5,10,12), Pearson education, 2nd Edition, 2010, ISBN: 9781119994367

Reference Books:

1. David A. Spera: "Wind Turbine Technology: Fundamental Concepts of Wind Turbine Engineering" (Chapters 2,4,6,8,11,13,14), ASME Publication, 2010, ISBN: 9780791802601.
2. Paul gipe: "Wind energy basics", (Chapters 1-3,10), Chelsea Publication, 2nd Edition, 2010, ISBN: 9781603580304.

E-Resources:

1. http://nptel.ac.in/courses/108105058/24

Lab VIEW - Level I

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18HOE661	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Understand the fundamental of graphical coding system.
- Learn to develop basic level of LabVIEW coding.
- Study the different component of LabVIEW operating tools.
- Study and develop state machine for a specific problem.
- Develop integrated coding solution for analysis and presentation with MyRio hardware using accelerometer.

Syllabus

Module - I

LabVIEW programming concepts, environment and Software constructs: Data flow, Polymorphism, Front panel window, block diagram, and connector pane, Menus and palettes, Configuration options. Controls, indicators, IO controls, and refnums Terminals, constants, nodes, update modes, and legends of charts and graphs. Mechanical action of Boolean objects Property Nodes. Numeric, string, Boolean, and path data types. Array and cluster data types. Shift registers, Case, Sequence and Event structures. **10 Hours**

Module - II

Programming, Data communication and synchronization VIs and functions: Conversion, comparison, and manipulation, Timing and Timing functions related to Timed structures. Data storage and file I/O formats, Waveform and waveform file I/O, Dynamic and User events Local, global, and shared variables Data Socket TCP and UDP Notifiers Queues Semaphores Property Nodes, and Invoke Nodes. **08 Hours**

Module - III

Error handling VIs and functions: Error clusters Dialog and User Interface VIs Custom error codes.

Design patterns: Simple state machine, User interface event handler, Queued message handler, producer/consumer (data) and

producer/consumer (events), Functional global variables. **06 Hours**

Module - IV

Sub VI design: SubVI creation methods, Connector panes and connection types, Polymorphic subVIs, Options related

Debugging tools and techniques: Debugging tools, Error list window, Execution highlighting, Breakpoints and single stepping, Generic and custom probes, Debugging practices and techniques for different situations. **08 Hours**

Module - V

VI design and documentation (style) practices: Refer to the LabVIEW Style Checklist topic of the LabVIEW Help for information on the following items

i. User interface design and block diagram layout
ii. Modular and hierarchical design
iii. SubVI icons and connector pane layout (standard)
iv. Properties
v. Documenting Vis

Memory, performance, and determination

a. Tools for identifying memory and performance issues

   Profile memory and performance, Show buffer allocations and VI metrics

b. Programming practices

Enforcing dataflow, User interface updates and response to user interface controls, Data type selection, coercion, and buffer allocation, Array, string, and loop operations **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Formulate basic aspects of the graphical programming using LabVIEW 2016.
- Develop LabVIEW coding for a specific problem of datalogging, measurement and presentation.
- Handle the error function and errors in the LabVIEW coding.
- Develop coding for data handling and Analysis on the acquired data.

- Design a state machine LabVIEW coding for an applied problem.

Text Books:

1. “LabVIEW - Getting Started with LabVIEW”, M/s National Instruments, 2013 373427J-01.
2. Jovitha Jerome: “Virtual instrumentation using labview”, PHI Learning Pvt. Ltd., 2010.
3. Hans-Petter Halvorsen: ”Introduction to LabVIEW,” University College of Southeast, Norway.
4. S. Sumathi, P. Surekha, “LabVIEW based Advanced Instrumentation Systems”, Springer.
5. Lab manual provided by Dept. of Civil Engg., NCET.

Reference Books:

1. Jeffrey Travis, Jim Kring: “Introduction to Graphical Programming with LabVIEW”, Pearson, 2006.
2. Malan Shiralkar: “LabVIEW Graphical Programming Course Collection”, National Instruments.

E-Resources:

1. http://cnx.org/content/col10241/1.4.

Yoga and Meditation

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18HOE662	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Introduce the main principles of Yoga.
- Generate knowledge and skills of students to use the tools and techniques for using Yoga in day to day life for better health and well being.
- Improve communication and increase concentration through Yoga and Meditation.
- Equip the individual to handle stressful situations and manage day to day activities.

Syllabus

Module – I

Definition and meaning of yoga: Meaning of Asanas, Types of Asanas: standing, sitting and supine asanas. Standing Asanas (Trikon asan, padhastasan, ardhachakrasan, veerbhadrasan), Sitting Asanas (Vajrasan, padmasan, suptavajrasan, Ardhamaschendrasan, vakrasan), Supine Asanas (Sarvangasan, Matsyasan, Natarajasan, Shavasan) **08 Hours**

Module – II

Patanjali's Yoga Sutra: Eight limbs of yoga, Importance of discipline in Yoga, Stillness of mind, Five Modulations (vritti) of the mind, Practice and Dispassion, Obstacles in the path of Yoga, Overcoming distractions of the mind through Yoga. **08 Hours**

Module – III

Understanding physiological implications of Yoga, Three types of Gunas (Satva, Rajas and Tamas) and their effects on body and mind, Food Habits, Meaning of Prana, Pranayama and its advantages, Different types of Pranayama. **08 Hours**

Module – IV

Ayurveda: The science of life, Three types of doshas (Vata, Pitta and Kapha), Balancing the different doshas for a healthy life, Ayurvedic principles of food and activity, Advanced Asanas: Mayurasana, Sirsasana, Gomukh Asana, Vrkshasana, Baddha Konasana. **08 Hours**

Module – V

Meditation: Meaning of meditation, Meditation vs Concentration, Advantages of Meditation, Effects of Meditation on body and mind, Effect on health and general well being, Reducing stress through meditation, Increasing concentration, Improving communication, Effect on Environment **08**

Hours

Course Outcomes:

On completion of this course, students will be able to :

- Know the basic principles of Yoga.
- Know and practice the basic asanas and their benefits.
- Use Pranayama and Meditation for improving health and mental peace.
- Know the difference between meditation and concentration.
- Apply the principles of Ayurveda and implement them for one's benefit.

Text Books:

1. Yoga Sutras of Patanjali (ancient text).
2. B K S Iyengar: "Light on Yoga".

Reference Books:

1. A traditional touch to Yogasanas for beginners and Sadhakas, Swami Vivekananda Yoga Prakashana (SVYP).
2. Dr. Vasant Lad: "Ayurveda: The Science of Self-Healing: A Practical Guide".

Martial Arts

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18HOE663	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

The following types of Martial arts are offered,

1. Karate
2. Taekwondo
3. Judo
4. Kung-fu

Expert Trainers will be provided during the academic year through experts in Martial Arts. Students who enroll for this elective should attend the regular Training classes and maintain a minimum of 85% attendance.

At the end of the training programme the performance Evaluation will be made by team of experts. Students who secure at least a satisfactory grade will be issued a certificate and deemed to have been completed the above said 3 Credit course. However, the students who have shortage of attendance will be consider for the award of 3 credits provided they undergo training at any of the training centers in the above said Martial Arts, complete the certification programme and give a demo along with viva in the presence of experts in the campus.

Music (Carnatic Vocal/Instrumental)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18HOE664	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Get familiarized with the conceptual understanding of Carnatic music.
- Gain knowledge about the basics of Swaravalis.
- Understand the use of different Talas.
- Gain understanding about various Raagas.
- Gain understanding about intricacies of Swaras.

Syllabus

Module – I

Theoretical Aspects: Father of Carnatic music, Famous personalities in Carnatic music, Concept of Sapta Swara, Taala, Melody, Pitch, Rhythm, Janaka Raaga, Janya Raaga. **03 Hours**

Module – II

Sarale Varase (Any 5), Janti Varase (Any 5), Daatu Varase, Tara Stayi, Mandra Stayi.

08 Hours

Module – III

Alankaras: Druva Taala, Matya Taala, Triputa Taala, Rupaka Taala, Jampe Taala, Atta Taala, Eka Taala. **08 Hours**

Module – IV

Geethagalu, Pillari Geethe (4), Sanchari Geethe (5), Lakshana Geethe (1). **10 Hours**

Module – V

Swarajatis (Any 2), Kalyani, Bilahari, Neelambari, Kamach.
Varna (Any 2), Shankarabarana, Kalyani, Hamsadwani , Mohana. **10 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Gain knowledge about the theoretical background of carnatic music
- Acquire practical knowledge on basics of Carnatic music.
- Practical demonstration of different Talas.
- Distinguish among various Raagas based on swara sthanas.

- To synchronize the Raaga and Taala.

Text books:

1. Dr. Sachidevi: "Karnataka Sangeetha Darpana", Sreenivasa Prakashana, Bengaluru, 2014.
2. Junior Carnatic Music – C Shiva Musicals, Malleshwaram, Bengaluru, 2013.

Dance (Bharatanatya)

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18HOE665	2:0:0: 4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Gain theoretical knowledge about various types of Indian dances.
- Understand about various musical instruments used in Bharatanatya.
- Learn Practical demonstrations of Bharatanatya steps on Prarthane Namaskara and Shlokas.
- Learn the movements of head, neck, eyes, hands according to Bharatanatya steps.
- Learn the brisk movements in Bharatanatya with the help of ADAVUS.

Syllabus

Module – I

Indian Classical dance, It's history and Significance, Types of Classical Dance, Bharatanatya, Kathakali, Mohini Attam, Koochipudi, Katahak, Odissi, Manipuri.

04 Hours

Module – II

Musical Instuments used in Bharatanatya: Tabala, Mrudanga, Kamsale, Kolata, Taala vadya. Famous personalities in Bharatanatya, Composers of Natya Grantas.

03 Hours

Module – III

Practical exercises on Prarthane, Namaskara and Shloka, Vyayama Kriye for Bharatanatya (Two Shlokas and Two Prarthanes). **10 Hours**

Module – IV

Abhinaya Steps (Chaturvidha) ShiroBedha, Drushti Bedha, Greeva Bedha, Brubedha, Hasta Bedha (Samyuta and Asamyuta). **10 Hours**

Module – V

Adavugalu (DashaVidha) Tattu adavu, Mettu Adavu, Nat Adavu, Egaru Tattu Adavu, Egaru Mettu adavu, Jaaru Adavu, Mandi adavu, TattuMettu Adavu, Rangakarma Adavu, Teermana Adavu. **12 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Get an insight into various types of Indian dances.
- Gain knowledge of different instruments used to perform dance.
- Perform exercises on prarthane, Namaskara according to Bharatanatya

style.

- Perform basic steps in Abhinaya.
- Recognise and perform different Adavus.

Reference Book:

1. "Bharatanatya shastra", Department of Public Instruction, Karnataka State Government**.**

Sports

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18HOE666	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

Students who are selected by the University to represent the VTU teams and for participating at State level / National level Sports in the following sports are exempted from taking open elective (Code:15HOE666) and will be awarded 3 credits.

Outdoor games	Indoor games
Cricket	Carrom
Foot ball	Chess
Hockey	Shuttle Badminton
Basket Ball	Squash
Kabbadi	Table – Tennis
Kho – Kho	Gymnastics
Hand – Ball	
Athletics	
Swimming	
Lawn Tennis	

The achievement in Sports as said above should have been made during the academic year during which the said open elective is offered.

After representing at VTU / State / National level in any of the above said sports, the students should produce the certificates from the competent authorities. Based on the certificates the institution will issue another certificate related to the achievement and awarding of three credits.

Fluid Machinery Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEL67	1:0:2:0	2	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Know the losses in flow through pipes.
- Understand the importance of fluid flow measuring devices.
- Learn the working of turbines.
- Study the performance of pumps and compressors.

Syllabus

PART-A

1. Determination of force developed by impact of jets on vanes.
2. Calibration of v-notch
3. Flow measurement using Rectangular notch
4. Flow measurement using flow nozzle

PART-B

1. Performance testing of Impulse Water Turbines
2. Performance testing of Reaction Water Turbines
3. Performance study of single stage / multi stage centrifugal pump
4. Performance study of Reciprocating Pump
5. Performance test of a two stage Reciprocating Air Compressor.
6. Performance test on an Air Blower.

Course Outcomes:

On completion of this course, students will be able to :

- Describe the friction losses for different diameters of pipes.
- Calibrate various measuring devices in fluid flow measurement.
- Apply the power generation by using turbines**.**
- Evaluate the performance of compressor and pumps**.**

Conducting classes:

Classes may be conducted in one slot per week, of 3 hours (Instruction 1 Hr. + Conduction and Calculation 2 Hr.)

Scheme of Evaluation:

Individual Experiment:	15 Marks
Group Experiment:	25 Marks
Viva-voce:	10 Marks

TOTAL:	**50 Marks**

Technical Aptitude and GD

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEH69	2:0:0:0	2	CIE:50 SEE:50	3 Hours	HSS

The respective branches shall conduct training programmes related to important and latest programming languages and other emerging technologies, such as Solar and Electric power based gadgets, IoT, ROBOT's, Environmental friendly and cost effective construction techniques, UAV's and technologies pertaining to the respective department.

Mechanical Vibrations (IC)

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEI71	3:0:2:0	4	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Impart knowledge on the concept of mechanical vibrations, principal of super position and method of determination of natural frequency for undamped free vibrations of a system.
- Understand the effect of damping on vibratory systems and to lay a strong foundation of forced vibrations of a single degree freedom system.
- Learn various types of vibration measuring instruments, modal analysis and condition monitoring methods.
- Educate the students regarding mathematical model of two degree freedom system, coordinate coupling and methods to determine the natural frequency of system.
- Study the importance of multi degree of freedom systems and learn the ways to find out their natural frequencies using numerical methods.

Syllabus

Module – I

Fundamentals of Vibrations: Concept of Vibration, Definitions, Type of vibrations, Simple Harmonic Motion (SHM), Principle of super position applied to SHM, Beats, Fourier theorem, numerical problems.

Undamped Free Vibrations of Single DOf systems: Introduction, Derivation of differential equations, Natural frequency of simple systems, Springs in series and parallel combinations, Effect of mass of spring, Torsional vibrations, numerical problems. **10 Hours**

Module – II

Damped Free Vibrations of Single DOF systems: Types of damping, viscous damping. Derivations for over, critical and under damped systems, Logarithmic decrement, numerical problems.

Forced Vibrations of Single DOF systems: Introduction, forced vibration with constant harmonic excitation - magnification factor, rotating and reciprocating unbalances, excitation of support (relative and absolute

amplitudes), Force and motion transmissibility, numerical problems. **10 Hours**

Module – III

Vibration Measuring Instruments and Critical Speeds of Shafts: Introduction, Vibration measuring scheme, Vibrometers, Accelerometer, Frequency measuring instruments, Whirling of shafts with and without damping, numerical problems on critical speed of shaft.

Modal analysis and Condition Monitoring: Signal analysis, dynamic testing of machines and structures, Experimental modal analysis, Machine condition monitoring and diagnosis. **10 Hours**

Module – IV

Systems with two degrees of Freedom: Introduction, Principle modes of vibrations, Normal mode and natural frequencies of systems, Double pendulum, Torsional systems, static and dynamic coupling, Undamped dynamic vibration absorber, numerical problems. **10 Hours**

Module – V

Numerical Methods for multi degree freedom of systems: Introduction, Maxwell's reciprocal theorem, Influence coefficients, Rayleigh's method, Dunkerley's method, Stodola method, Holzer's method, numerical Problems. **10 Hours**

List of Experiments:

1. Determination of natural frequency of simple pendulum.
2. Determination of critical speed of the shaft.
3. Study the effect of damping and torsional vibration.
4. Analyze the free vibration of spring mass system.
5. Analyze the forced vibration of spring mass system.
6. Determination of modal frequency and mode shape using FFT.

Course Outcomes:

On completion of this course, students will be able to :

- Apply the basic concepts of vibrations to idealise realistic problems into mathematical model and can solve those problems in mechanical engineering design.
- Develop skills to deploy the different damping systems (Under, over and critically damped) for different applications and can utilise the concept of forced vibrations to carry dynamic analysis of mechanical components
- Realize the importance of vibration measuring instruments, condition monitoring and methods to reduce the vibrations.

- Idealise any physical system into two DOf systems and determines their
  mode shapes.
- Solve multi DOF system and obtain their natural frequencies, which helps the engineer to design stable systems. .

Text Books:

1. S. S. Rao: “Mechanical Vibrations”, Pearson Education Inc, (Chapters 1-7,9,10), 2010, 5th Edition, ISBN-13: 978-0132128193.
2. V. P. Singh: “Mechanical Vibrations”,(Chapters 1-6), Dhanpat Rai Publications, 4th Edition, 2014, ISBN: 978-8157004014.

Reference Books:

1. G. K.Grover: “Mechanical Vibrations”, Nem Chand and Bros, (Chapters 1-5,7,8),
   8th Edition, 2009, ISBN-13: 978-8185240565.
2. J. S. Rao, K. Gupta: “Theory and Practice of Mechanical Vibrations”, (Chapters 1-5,7), New Age International Publications, New Delhi, 2nd Edition reprint, 2014, ISBN: 978-81-224-1215-4.

E-Resources:

1. http://nptel.ac.in/courses/112103111/
2. https://ocw.mit.edu/courses/mechanical-engineering

Heat and Mass Transfer

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET72	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand Modes and basic laws of heat transfer, one dimensional steady state conduction through plane wall, cylinder, sphere of uniform and non uniform thermal conductivity with and without heat generation.
- Know the unsteady state conduction with lumped analysis and use of Heisler charts.
- Study convective heat transfer in free and forced convection from walls, cylinder etc under different conditions with the use dimensional analysis method.
- Learn heat exchangers with LMTD and NTU methods.
- Impart knowledge of radiation heat transfer for different cases including radiation shield and learn the basis of diffusion and convective mass transfer and also learn the heat transfer with change of phase i.e. boiling and condensation.

Syllabus

Module – I

Introductory concepts: Modes of Heat Transfer, Basic Laws of Heat Transfer, Overall Heat Transfer Coefficient, Boundary Conditions, 3-D Conduction equation In Cartesian coordinates, Discussion On 3-D Conduction equation in Cylindrical and Spherical coordinate systems (No Derivation). 1-D Conduction equations in Cartesian, Cylindrical and Spherical Coordinate Systems. Composite Walls, Cylinders and Spherical Systems with Constant Thermal Conductivity, Numerical Problems.

10 Hours

Module – II

One-Dimensional Transient Conduction: Conduction insolids with negligible internal temperature gradient (Lumped system analysis), Use of Transient

temperature charts (Heisler's charts) for transient charts for transient conduction in semi-infinite solids. Numerical Problems. **08 Hours**

Module – III

Introduction to boundary layers Concept

Natural or Free convection: Application of dimensional analysis for free convection. Physical significance of Grasshoff number, Rayleigh number. Use of correlations in free convection for horizontal, vertical plates and cylinders.

Forced convection heat transfer: Application of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of correlations for hydro-dynamically and thermally developed flows in case of a flow through tubes, flow over a flat plate, cylinder and across a tube bundle. Numerical problems. **08 Hours**

Module – IV

Heat exchangers: Classification of heat exchangers, Tubular and compact heat exchangers, overall heat transfer coefficient, fouling factor, L.M.T.D method, effectiveness, NTU method of analysis of heat exchangers, Numerical problems.

08 Hours

Module – V

Introduction to Condensation heat transfer:

Radiation heat transfer: Thermal radiation, definitions of various terms used in radiation heat transfer, Stefan-Boltzman law, Kirchoff`s law, Planck`s law and Wein`s displacement law, Radiation heat exchange between two parallel infinite black surfaces and gray surfaces, effect of radiation, Radiation shape factor, properties of shape factors, Numerical problems.

Introduction to Mass Transfer: Fick`s law of diffusion mass transfer. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Analyze and calculate one dimensional steady state conduction heat transfer through plane wall, cylinder, sphere of uniform and non-uniform thermal conductivity with and without heat generation.
- Determine temperature and heat flow for unsteady state conduction also analyzes unsteady state conduction problems with lumped analysis and using Heisler charts.
- Demonstrate the evaluation of convective heat transfer in free and forced convection from walls, cylinder etc under different conditions.
- Design of heat exchangers using LMTD and NTU methods.

- Workout the radiation heat transfer problems for different cases including radiation shield and also solve simple numerical on diffusion and convective mass transfer. And also demonstrate the heat transfer with change of phase that is boiling and condensation.

Data Hand Books:

1. C.P. Kothandaraman, S Subramanyan: "Heat and Mass Transfer", New Age International Publisher.
2. R. Niranjanmurthy: "Thermodynamic Data Hand Book", Sapna Book House, ISBN: 9788128000041.

Text Books:

1. S.C. Sachdev: "Heat and Mass Transfer", (Chapters 1-10), New Age International,4th Edition, 2010, ISBN: 978-8122427851.
2. Ozisik: "Basic Heat Transfer", (Chapters 1-7), McGraw-Hill Publications, 1st Edition, 2011, ISBN: 978-0070479807.

Reference Books:

1. Yunus A Cenegal: "Heat Transfer, a practical approach", (Chapters 1-5),Tata McGraw-Hill Publishers, 2nd Edition, 2006, ISBN: 978-0072458930.
2. J.P Holmon: "Heat Transfer", (Chapters 1-3), McGraw-Hill Publishers, Special Indian Edition, 2011, ISBN: 978-0078447853.

E-Resources:

1. http://nptel.ac.in/courses/112101097/

Engineering Management and Entrepreneurship

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET731	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Understand the motivational behavior in an organization/industry.
- Know the overall productivity in a shop floor.
- Study the directing Leadership styles.
- Educate students project preparation.
- Know the Government policy towards SSI.

Syllabus

Module – I

Management and planning: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management, Management and Administration - Roles of Management, Levels of Management, Development of Management Thought - early management approaches – Modern management approaches, importance and purpose of planning process, Types of plans, Decision making, steps in planning, Hierarchy of plans. **08 Hours**

Module – II

Organizing and Staffing: Nature and purpose of organization, Principles of organization, Types of organization, Departmentation Committees, Centralization Vs Decentralization of authority and responsibility, Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--:Process of Selection and Recruitment (in brief). **08 Hours**

Module – III

Directing and Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication-Meaning and importance, coordination- meaning and importance and Techniques, Meaning and steps in controlling-Essentials of a sound control system, Methods of establishing control (in brief). **08**

Hours Module – IV

Entrepreneurship and Project preparation: Meaning of Entrepreneur; Evolution of .the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Stages in entrepreneurial process, Role of entrepreneurs in Economic Development, Entrepreneurship in India, Entrepreneurship - its

Barriers. Meaning of Project; Project Identification; Project selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Errors of Project Report; Project Appraisal, Identification of business opportunities: Market

Feasibility Study; Technical Feasibility Study; Financial Feasibility Study and Social

Feasibility Study. **08 Hours**

Module – V

Small Scale Industries and Institutional Support: Definition of SSI, Characteristics, Objectives, Scope role of SSI in Economic Development, Advantages of SSI, Steps to start an SSI Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI, Effect of WTO/GATT, Supporting Agencies of Government for SSI, Meaning, Nature of institutional support, Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC;DIC Single Window Agency; SISI, SIDBI. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Describe the motivational behavior in an organization/industry.
- Design the overall productivity in a shop floor.
- Analyze the directing leadership styles.
- Explain Project preparation.
- Implement Government policy towards SSI.

Text Books:

1. P.C.Tripathi, P.N. Reddy: “Principles of Management”, (Chapters 1,4,7,11), Tata McGraw Hill, New Delhi, 4th Edition,2011, ISBN: 978-0-07-022088-1.
2. Poornima. M. Charantimath: “Entrepreneurship Developments–Small Business Enterprises”, (Chapters 1,2,4,5), Pearson Education, 3rd Edition, 2008, ISBN: 978- 81-7758-200-4.
3. V R Naidu, T Krishna Rao: “Management and Entrepreneurship”, (Chapters 1-3,5,12-14), International New Delhi, 1st Edition, 2008, ISBN: 978-81-906757-8-9.

Reference Books:

1. Vasant Desai: ”Dynamics of Entrepreneurial Development and Management” , (Chapters 2,3,5,7,8 and 9) , Himalaya Publishing House, 1st Edition 209, ISBN: 978- 81-84884-18-0.
2. S S Khaka, S Chand: “Entrepreneural Development”, (Chapters 1-

3,12,13,21), 2013, ISBN:81-219-1801-4.

3. Robert N Lussier, "Fundamentals of Management", (Chapters 1-3), Cengage Learning Private Ltd., New Delhi, 2010, ISBN: 978-81-315-1315-0.

E-Resources:

1. http://nptel.ac.in/courses/110105067/
2. http://nptel.ac.in/courses/122106032/26

Hydraulics and Pneumatics

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET732	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Provide a sound understanding of the working of hydraulic and pneumatic systems.
- Understand the energy transfer in hydraulic actuators and motors
- Know about controlling components of hydraulic and pneumatic systems.
- Design of hydraulic and pneumatic systems and analyze them.
- Introduce the concept of signal processing elements and control.

Syllabus

Module – I

Introduction to Hydraulic Power: Pascal's law and problems on Pascal's Law, continuity equations, introduction to conversion of units, Structure of Hydraulic Control System. The Source of Hydraulic Power: Pumps Pumping theory, pump classification, gear pumps, vane pumps, piston pumps, pump performance, pump selection. Variable displacement pumps.

Hydraulic Actuators: Linear Hydraulic Actuators [cylinders], Mechanics of Hydraulic Cylinder loading. **07 Hours**

Module – II

Hydraulic Motors: Hydraulic Rotary Actuators, Gear motors, vane motors, piston motors, Hydraulic motor theoretical torque, power and flow rate, hydraulic motor performance.

Control Components in Hydraulic Systems: Directional Control Valves – Symbolic representation, Constructional features, pressure control valves – direct and pilot operated types, flow control valves. **09 Hours**

Module – III

Hydraulic Circuit Design and Analysis: Control of single and double – acting hydraulic cylinder, regenerative circuit, pump unloading circuit, counter balance valve application, hydraulic cylinder sequencing circuits. Cylinder synchronizing circuits, speed control of hydraulic cylinder, speed control of hydraulic motors, Accumulators.

Maintenance of Hydraulic Systems: Hydraulic oils; desirable properties, general type of fluids, sealing devices, reservoir system, filters and strainers, problem caused by gases in hydraulic fluids, wear of moving parts due to solid particle contamination, temperature control, trouble shooting. **08 Hours**

Module – IV

Introduction to Pneumatic Control: Choice of working medium, characteristics of compressed air. Structure of pneumatic control system. Compressed air: Production of compressed air – compressors, preparation of compressed air- Driers, filters, regulators, lubricators, distribution of compressed air.

Pneumatic Actuators: Linear cylinders – types, conventional type of cylinder working, end position cushioning, seals, mounting arrangements applications. **08**

Hours

Module – V

Directional Control Valves: Symbolic representation as per ISO 1219 and ISO 5599. Design and constructional aspects, poppet valves, slide valves spool valve, suspended seat type slide valve. Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, use of memory valve. Flow control valves and speed control of cylinders supply air throttling and exhaust air throttling, use of quick exhaust valve.

Signal Processing Elements: Use of Logic gates – OR and AND gates pneumatic applications, practical examples involving the use of logic gates, Pressure dependent controls types construction– practical applications, time dependent controls – principle, construction, practical applications. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Describe the working of hydraulic and pneumatic systems.
- Become aware about controlling components of hydraulic and pneumatic systems.
- Select, prepare and distribution of compressed air.
- Compile the design of hydraulic and pneumatic systems.
- Demonstrate the need of pressure and time dependent controls.

Text Books:

1. Anthony Esposito: “Fluid Power with applications”, (Chapters 1-10), Pearson Education, 5th Edition, 2010, ISBN-13-8456425689034.
2. Andrew Parr: “Pneumatics and Hydraulics”, (Chapters 1-8), Jaico Publishing Co., 2011, 1st Edition, ISBN-13: 8975356789053.

Reference Books:

1. Dr. Niranjan Murthy and Dr. R.K.Hegde: “Hydraulics and Pneumatics”, (Chapters 1-6,9,10), Sapna Publications, 2013, ISBN-13: 876521342609.
2. S.R. Majumdar: “Pneumatic Systems”, (Chapters 1-6), Tata McGraw Hill Publishing,
   1st Edition, 1995, ISBN: 978071359658.

E-Resources:

1. http://nptel.ac.in/courses/112105046/
2. http://nptel.ac.in/courses/112103174/21

Module –

Heating Ventilation and Air Conditioning (HVAC)-III

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET733	3:0:0:0	3	CIE:50 SEE:50	3 Hours	FE

Course Objectives:

This course will enable students to :

- Understand of Energy Conservation and Sustainability.
- Know the Fundamentals of good indoor air quality.
- Study the working of Exhaust Systems.
- Impart the knowledge of ventilation and airflow calculations.
- Learn the Design of commercial, Residential ventilation system.

Syllabus

Module – I

Energy Conservation and Sustainability: Design aspects, Energy recovery, Energy- Efficiency by Operation and Maintenance, Normal Working Pressures, Operation of plant, Power Factor, Energy Conservation-Government and Industry Initiatives, Energy Conservation Building Code Star Labelling, The Green Building Movement, the rating System. **08 Hours**

Module – II

Fundamentals of good indoor air quality: Need for building ventilation, Effects of
R.H. in building ventilation, Control of microbial growth, Psychometric performance of contact volume system, Types of ventilation system. Supply system, Exhaust system. **08 Hours**

Module – III

Exhaust Systems: General exhaust systems. Local exhaust system, Removal of pollutants and contaminated air, Air cleaning devices, Fans. **08 Hours**

Module – IV

Ventilation in Kitchen: Cooking, Exhaust flow, IMC (International Mechanical Code) Calculation of appliances area, contaminated air, Free foot area. Total air flow volume with example. Types of hood, Design of hood. Design factors, Integrated air curtains, Combinationhood. **08 HoursVentilation of Commercial Building:** Design of commercial, Residential ventilation system. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Demonstrate importance of Energy Conservation and Sustainability.
- Describe the Fundamentals of good indoor air quality.
- Identify the types of General exhaust systems in Air- Conditioning systems.
- Analyze the Ventilation needs and necessity.
- Apply the design of commercial, Residential ventilation system.

Text Books:

1. Hazim, B. Awbi, Routledg: "Ventilation Systems: Design and Performance", (Chapters 1-6,9,10), Taylor and Francis, 1st Edition, 2007, ISBN: 978-041921708.
2. Neil McManus: "Portable Ventilation Systems Hand Book", (Chapters 1-5,10), CRC Press, 1st Edition, 2000, ISBN: 9781760328933.

Reference Books:

1. John L Alden: "Design of Industrial Ventilation Systems", (Chapters 1-5,10), Industrial Press, 5th Edition, ISBN: 0831111380.
2. ISHRAE Hand Book: "Industrial Ventilation Applications", 2009.

E-Resources:

1. http://nptel.ac.in/courses/112105129/

Safety, Security and Building Management Systems

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET741	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Understand the role of fire alarm system and how public address system works.
- Study principles and objective of a Fire Suppression System.
- Learn the concept and process of access control and intruder alarm.
- Know the working and components of CCTV and perimeter protection system.
- Impart the objectives of integrated building management system.

Syllabus

Module – I

Safety Systems – Fire Alarm and Public Address System: Objective of a Fire Alarm System, essential components of a Fire Alarm System, Type of detection technology currently in use and Statutory Standards to be followed in design. Explanation of the essential Clauses of the the codes, and various types of Technologies employed in the Fire Alarm System, basic knowledge on how a Fire Alarm system works, designed and installed. Objective of a Public Address System, essential components of a Public Address System, various types of technologies currently in use and design guidelines to be followed and basic knowledge on how a Public Address System works, is designed and installed. **08 Hours**

Module – II

Safety Systems-Fire Suppression System: Objective of a Fire Suppression System, Explanation on Fire triangle, Essential Components of a Fire Suppression System, different type of Fire Suppression Systems, detailed design criteria for Hand held extinguishers Wet Riser, Sprinkler Systems and various gas Based Fire Suppression System, and Type of Statutory Standards followed in Suppression, Explanation on the essential Clauses and Basic Knowledge on how a Fire Suppression System works, is designed and

installed. **08 Hours**

Module – III

Security Systems – Access Control System And Intruder Alarm System: Introduction to Access Control, Intruder Alarm, Essential Components of each System, and Various types of Technologies employed in the system, Basic knowledge as how they work, are designed and installed. **08 Hours**

Module – IV

Security Systems – Cctv And Perimeter Protection: Introduction to CCTV, Perimeter protection system, Essential Components of each System, and Various types of Technologies employed in the system, Basic knowledge as how they work, designed and installed. **08 Hours**

Module – V

Integrated Building Management System: Objective of the Integrated Building Management System (IBMS), the list of utility, safety and security systems that are generally monitored and controlled through IBMS, the various components of IBMS, types of integration with the utility, Safety and security systems, explanation in detail on how each utility, safety and security system is integrated to IBMS, details of various parameters that can be monitored and controlled on each utility, safety and security system and the basic knowledge on how they work, are designed and installed.

08 Hours

Course Outcomes:

On completion of this course, students will be able to :

- Describe of the basic knowledge of essential components of a Fire Alarm System.
- Demonstrate the working of Fire Suppression System.
- Identify the various types ofSecurity Systems.
- Use the various types ofcctv and its components.
- Apply the integrated building management system.

Text Books:

1. Maurice Eyke: “Building Automation Systems – A Practical Guide to Selection and Implementation”, (Chapters 1-7), Blackwell Science Inc. Publishing, 1st Edition, 2010, ISBN: 978-0632019366.
2. Mike Constant, Peter Turnbull: “The Principles and Practice of Closed Circuit Television”, Paramount Publishing, 1st Edition, 1994, ISBN: 9780947665203.

Reference Books:

1. National Building Code of India 2017 (Part IV)
2. Bureau of Indian Standards IS2189, IS2190, IS15105, IS13039.
3. John L. Bryan: “Fire Suppression Detection System”.
4. Vivian Capel: “Security Systems and Intruder Alarm System”.

E-Resources:

1. http://nptel.ac.in/courses/103106071

Foundry Technology

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET742	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Understand the basics of Foundry metallurgy and casting design.
- Impart the knowledge of solidification.
- Learn the design aspects of casting, risering and gating system.
- Study Special casting techniques and an overview of mechanized foundry.
- Know the standard foundry practice for casting of ferrous and non-ferrous alloys.

Syllabus

Module – I

Introduction to Foundry: Oxidation of Metals, Gas dissolution in liquid Metals, Methods of degassing, Fluidity, factors affecting Fluidity, hot tearing, Shrinkage of liquid metals.

Casting design: Introduction to casting design, redesign considerations, design for minimum casting stresses, design for directional solidification, design for metal flow, safety factors, design for low pattern cost. **09 Hours**

Module – II

Solidification of Castings: Introduction, Crystallization and development of cast structure, Nucleation and growth , Dendrite growth, Structure of castings, Significance and practical control of cast structure, Concept of progressive and directional solidification, Solidification time and Chvorinov'srule. **07 Hours**

Module – III

Risering: Need for risering , Riser shape , size, Types of risers, Design and location of feeder heads, Design modifications, padding, chills and insulation.

Gating of Castings: Introduction, Essential features of gating system, Design of gating system,laws of fluid flow, General aspects of gating practice, Forces

acting on the mould, gating ratio and simple problems. **08 Hours**

Module – IV

Special Casting Techniques: Principle, materials used, process details and application of Vacuum Process or V-Process , Dissamatic moulding or Flaskless moulding.**upola Melting:** Construction, Preparation and Operation of the cupola, Zones of Cupola Charge calculations.

Modernization and Mechanization: Introduction, Need for modernization, mechanization, Elements of Mechanization, Moulding line mechanization, Mechanization of Melting , Pouring and shakeout units. Material Handling equipments, reclamation of sands. **08 Hours**

Module – V

Ferrous foundry: Melting procedures, casting characteristics, specification, and properties of some typical steels, gray cast iron, malleable iron, and spheroidal graphite cast iron castings.

Nonferrous foundry: Introduction, Melting procedure, Casting characteristics of aluminium based alloys, Copper based alloys, magnesium based alloys. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Explain the need of foundry technology and casting design.
- Demonstrate the solidification of castings.
- Apply the knowledge of gating and risering systems.
- Use the Special casting techniques, modern techniques, skills and engineering tools in a mechanized and modernized foundry.
- Have a broad knowledge of casting of ferrous and non-ferrous alloys.

Text Books:

1. P.L.Jain: “Principles of Foundry Technology”, (Chapters 10-17), McGraw Hill Education (India) Private Ltd., 1st Edition,209, ISBN-13: 978-0-07-015129-1.
2. S.K.Garg: “Workshop Technology”, (Chapters 4,7-9), Laxmi Publications, 2nd Edition, 2013, ISBN: 9788131806975.

Reference Books:

1. P.N.Rao: “Manufacturing Technology”, Volume-1, (Chapters 10-17), Tata McGraw Hill, 4th Edition, 2013, ISBN-13: 978-12590-62575.

2. S.K.Hajrachoudhury, A.K. Choudhury, Nirjharroy: “Elements of Workshop Technology(vol-1)”, (Chapters 2-4,11,16), Media Promoters, 2009, ISBN-13: 9788185099149.

E-Resources:

1. http://nptel.ac.in/courses/112107144/13

Biomass Energy Systems

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MET743	3:0:0:0	3	CIE:50 SEE:50	3 Hours	EE

Course Objectives:

This course will enable students to :

- Know the biomass sources of energy contents and the various biomass conversion methods.
- Understand conversion of biomass to biofuels for combustion process.
- Study of bio methanization process and calculation of biogas digestors.
- Impart the knowledge of Biofuels in IC engine combustion.
- Gain the knowledge in application of thermodynamics cycles in power generation.

Syllabus

Module-I

Biomass Energy And Biomass Conversion Methods: Introduction, Biomass sources, Energy content of various Bio–fuels, Energy plantation, origin of Biomass, photosynthesis process, Biomass Characteristics, Sustainability of Biomass.

Biomass Conversion Methods: Physical, agrochemical, thermochemical, biochemical (flowchart)and explanation. **08 Hours**

Module-II

Physical and Agrochemical Conversion: Briquetting, Pellatigation**,** Agrochemical, fuel Extraction, Thermo chemical Conversion: Direct combustion for heat, domestic cooking and heating.

Biomass Gasification: Chemical reaction in gasification, Producer gasand the constituents, Types of gasifiers: Fixed bed gasifiers, Fluidized gasifiers. **08 Hours**

Module-III

Liquefaction and Bio Methanization: Liquefaction through pyrolysis and Methanol synthesis. Anaerobic digestion, Basic principles, factors influencing Biogas yield, classification of Biogas digester: floating gasholder and fixed dome type (Working Principle with diagram). Calculation for sizing of biogas plant. **08 Hours**

Module-IV

Biogas For Power Generation: Ethanol as an automobile fuel, Ethanol production and its use in engines.

Bio – Diesel: Bio Diesel from edible and non-edible oils, Production of Bio diesel from Hongeand Jatropha seeds, use of bio diesel in I C engines, Engine power using Bio diesel, Blending of Bio diesel, Performance analysis of diesel engines using bio diesel. Effect of use of bio diesel in IC engines. **08 Hours**

Module-V

Bio Power Plants: Bio Power generation routes, Basic Thermodynamic cycles in Bio power generation; Brayton cycle, Sterling cycle, Rankine cycle, Co-generation cycle. Biomass based steam power plant. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Describe the various biomass resources and its conversion methods
- Analyze the conversion of biomass to biofuels for combustion process
- Demonstrate the concepts of biomethanation process and biogas digestor sizing
- Apply knowledge of biofuels in IC Engine Combustion
- Evaluate the performance of biomass based steam power plant for power generation.

Text Books:

1. G.N.Tiwari, M.K.Goshal: “Renewable Energy Resources: Basic Principles and applications”, (Chapters 1-6), Narosa Publishing House, Indian Editions, 2011, ISBN-13: 978071004992.
2. S.Rao and B.B. Panulkar: “Energy Technology”, (Chapters 4,5,7,8), Khanna Publishers, Delhi, 1999, 23rd Reprint Edition, 2011, ISBN: 9788189928469.

Reference Books:

1. Allan T. Kirkpatrick Colin R. Ferguson: “Internal Combustion Engine

Applied Thermosciences", (Chapters 1,9,10), Wiley India Pvt. Ltd.,1st Edition, 2008, ISBN: 978812653076.

2. AyhanDemirbas: "Green Energy and Technology",(Chapters 1-6),Springer-Verlag London Limited, 1st Edition, 2010, ISBN: 978-1-84882-010-4.

E-Resources:

1. http://nptel.ac.in/courses/108108078/7
2. http://nptel.ac.in/downloads/108108078/

Tax Management

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18HOE751	2:0:0: 4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Familiarise the students with the significance of taxation system.
- Understand the structure of Indian Taxation system.
- Gain knowledge about the practical aspects of Indian taxation.
- Understand the system of computation of tax from Salaries.
- Sketch the recent trends in Indian taxation system.

Syllabus

Module – I

Introduction to taxation system, Objectives of taxation, Factors to be considered for tax planning Canons of taxation, Types of taxation, Direct tax, Indirect tax (Broad perspective only). **07 Hours**

Module – II

Taxation system in India, Types of taxes levied in India, Various heads of income tax (Broad outline only} Basic concepts in taxation, Assessment year, Financial year, assessee, Residential status, Tax liability **08 Hours**

Module – III

Income tax authorities in India, Constitution, Powers, Functions specimen of Form 16, Filing of returns, tax evasion, Penalties for contravening the provisions of income tax. **08 Hours**

Module – IV

System of computation of tax from salaries, Taxable income, Permissible deductions from 80C to 80U Fringe benefits exempted from tax, exempted income under section 10 of Income tax act. **10 Hours**

Module – V

Trends in Indian taxation system, Self assessment, PAN card, Budgetary provisions of the financial year 2017-18 on taxation, GST, Advantages, Problems in implementing GST, Measures to overcome the limitations of GST. **06 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Gain knowledge about the system of taxation prevailing in the country.
- Compute tax under different heads.
- Gain practical knowledge on filing returns.
- Calculate the payable tax for salaried individuals.
- Gain insight into recent practices on taxation.

Reference Books:

1. Dr. Vinod K. Singhania: “Direct taxes-Law and Practice”, Taxmann Publication.
2. Dr. Mehrotra, Dr. Goyal: “Direct taxes- Law and Practice”, Sahitya Bhavan Publication.
3. “7 lectures-Income tax-I “, VBH.
4. Swaminathan: “Income Tax”, KPH.
5. T.N.Manoharan: “Income tax including VAT”.
6. R.G.Saha, Ushadevi: “Taxation”, HPH.

Module –

Assessment of Building Energy Performance

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18HOE752	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Provide a foundation for performing a building energy audit
- Perform assessment tasks on building energy performance
- Submit a Building EQ rating
- Understand the methods and processes to be performed in the field
- Know the process of certifying professionals in energy assessment

Syllabus

Module – I

Introduction, global energy consumption characteristics and the role of commercial and residential buildings, building energy end use consumption characteristics, impact of time variations in building energy consumption, Building mechanical, electrical, and lighting systems. **08 Hours**

Module – II

Anatomy of typical HVAC systems in commercial buildings , typical primary and secondary HVAC equipment and their role in meeting system requirements , basics of electrical distribution systems and their equipment in commercial buildings, basics of lighting system in buildings, including performance terminology, lighting technologies, energy performance, and the role of day lighting. **08 Hours**

Module – III

Introduction to building energy benchmarking and assessment , differences between benchmarking, labeling programs, and energy and environmental auditing, role of building type and climate zone on energy use, key aspects of ENERGY STAR® Portfolio Manager and other tools for benchmarking, ASHRAE Building EQ As Designed and In Operation ratings, differences between Building EQ and Portfolio Manager, Preliminary Energy Use Analysis (PEA). **08 Hours**

Module – IV

Measuring and monitoring building performance, instrumentation for measuring indoor environmental quality and building energy flows, Perform measurements of indoor environmental quality and building energy flows, accuracy of building measurements, Identify the components of an ASHRAE Level 1 walk through survey and the differences between Level 1, 2, and 3 surveys, Indoor Environment Quality.

08 Hours

Module – IV

Energy Efficiency Measures – Building Envelope and Lighting, role of building envelope characteristics on energy use, energy conservation and energy efficiency measures related to envelope and lighting characteristics, Energy Efficiency Measures – HVAC Systems, energy conservation and energy efficiency measures related to HVAC systems, financial analysis of expected improvements to HVAC systems. **08 Hours**

Course Outcomes:

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

- Produce an ASHRAE Building EQ In Operation rating for the buildings provided in the class.
- Produce a listing of potential Energy Efficiency Measures (EEM) including financial payback analysis.
- Perform measurements of indoor environmental quality and HVAC system performance.
- Identify different building types and determine the impact of climate on energy use.
- Analyze raw energy consumption data from measured-meter readings.

Text Books:

1. ASHRAE Building Energy Quotient Program website.
2. ASHRAE BEAP certification study guide.
3. ASHRAE Standard 105-2014 Standard Methods of Determining, Expressing, and Comparing Building Energy Performance and Greenhouse Gas Emission.

Reference Books:

1. ASHRAE Performance Measurement Protocols for Commercial Buildings: Best Practices Guide.
2. ENERGY STAR® Portfolio Manager website.

Module –

Natural Disaster Mitigation and Management

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18HOE753	2:0:0: 4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Understand the types of natural and environmental disasters.
- Develop skills in various stages of disaster preparedness, mitigation and management.
- Understand the methodologies for disaster risk assessment.

Syllabus

Module – I

Natural Disasters – Overview: Introduction- Natural Disasters around the world- Natural Disaster Risk Assessment- Earth and its characteristics Human Dimensions of Global environment Change – Disaster mitigation, preparedness, response and recovery comprehensive emergency management Early warning systems and Disaster Preparedness– Rehabilitation, Vulnerable Populations - Logistics and Services, Food, Nutrition and Shelter -Role of UN Red cross and NGOs. **08 Hours**

Module – II

Natural Hazards: Introduction and Review - Natural Disasters -Principles, Elements, and Systems - Geological-Geomorphological aspects, - Earthquake-Geology, Seismology, Characteristics and dimensions– Landslides- Human impact on the mountainous terrain and its relationship with Rainfall, liquefaction etc- Tsunami - Nature and characteristics. **08 Hours**

Module – III

Climate system aspects and Processes: Oceanic, Atmospheric and Hydrologic cycles

- Severe Weather & Tornadoes , Cyclones, Floods and Droughts - Global Patterns
- Mitigation & Preparation – Drought – Famine- nature and dimensions – Drought Assessment and Monitoring. **08 Hours**

Module – IV

Natural Disaster Communication: Mapping - Modeling, risk analysis and loss estimation – Natural disaster risk analysis - prevention and mitigation - Applications of Space Technology (Satellite Communications, GPS, GIS and Remote Sensing and Information / Communication Technologies (ICT) in Early warning Systems - Disaster Monitoring and Support Centre– Information Dissemination, mobile communication – etc. **08 Hours**

Administrative mechanisms: Community and Social organizations – Education and Training – Establishment of capacity building among various stake holders – Government - Educational institutions – Use of Multi-media knowledge products for self education. **08 Hours**

Course Outcomes:

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

- Learn about the types of natural and environmental disasters and its causes.
- Learn about organizational and Administrative strategies for managing disasters.
- Learn about the early warning systems, monitoring of disasters effect and necessity of rehabilitation.
- Learn about the engineering and non-engineering controls of mitigating various natural disasters.
- Understand the key roles of capacity building to face disaster among government bodies, institutions, NGO's, etc.
- Learn methodologies for disaster risk assessment with the help of latest tools like GPS, GIS, Remote sensing, information technologies, etc.

Text Books:

1. Kovach, Robert L :"Earth's Fury: An Introduction to Natural Hazards and Disasters", Englewood Cliffs, N.J., Prentice Hall, 1995.
2. Siddhartha Gautam, K Leelakrishna Rao: "Natural disaster Management", 3rd Edition, 2012, ISBN: 9381604320.

Reference Books:

1. Arul Jothi, D L Balaji: "Safety And Disaster Management Education in Schools",
1st Edition, Anmol Publications, 2009, ISBN: 9380252609.

E-Resources:

Module –

1. https://www.publicsafety.gc.ca/cnt/mrgnc-mngmnt/dsstr/bt-dsstr-mtgtn-en. aspx
2. www.nrdms.gov.in/natural_disaster.asp
3. https://www.ncbi.nlm.nih.gov › NCBI › Literature › Bookshelf

Small and Medium Enterprise Management

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18HOE761	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Understand the various concepts of Entrepreneurship and familiarize them with the understanding of contemporary environment of MSMEs.
- Understand the business Environment to MSMEs.
- Understand the process of Enterprise Creation.
- Understand the effective Business Plan and Institutional Support Mechanism.
- Understand the concepts of marketing management in the MSMEs.

Syllabus

Module – I

Basic Aspects: Concept, nature of Entrepreneur and Entrepreneurship, Distinction between Entrepreneur and Manager, Entrepreneurship, Medium, Small and Tiny Business : Definition, Role in the economy and significance, Changing scenario of MSMEs in the era of Liberalization and Globalization, Competitiveness. **08 Hours**

Module-II

Environment assessment: Political, Legal, Economic, Social, Technological, Global environment, Assessment of business opportunities, Government initiatives and private sector opportunity. **08 Hours**

Module-III

Enterprise Creation: Starting a small industry, Entrepreneurial function or process of starting a new venture based on personal competencies, requirements to start a business venture, Feasibility of the project, Business incubators . **08 Hours**

Module-IV

Business Plan: Developing effective business plan-meaning, benefits of

business plan, Timing of the business plan, Length of the business plan, composition of the business plan or detailed project report. Institutional Support Mechanism: District Industries Centre, State Directorate of Industries, SIDBI, NSIC, SISI, KSFC, KIADB, TECSOK.

08 Hours

Module-V

Small Business Marketing: Concept of Marketing, Scope of Marketing, Marketing Mix, Product Mix, Channels of Distribution, Market Segmentation, Role of Middlemen, Distribution Strategies, Sales Promotion, Advertising and Publicity, Packaging Strategies, Branding Strategies. **08 Hours**

Course Outcomes:

On completion of this course, students will be able to :

- Visualize the various concepts of Entrepreneurship and understand of current environment of MSMEs.
- Know the Business Environment with respect to MSMEs.
- Know the Process of Enterprise Creation.
- Prepare Business Plan and Understand the Institutional Support Mechanism.
- Know the marketing management with reference to MSMEs.

Text Books:

1. Shukla. M.B: “Entrepreneurship and Small Business Management”, Kitab Mahal, Allahabad, 2011.
2. Sahay A., V. Sharma: “Entrepreneurship and New Venture Creation”, Excel Books, New Delhi, 2008.
3. Lall, Sahai: “Entrepreneurship”, Excel Books, New Delhi, 2006.
4. S. Anil Kumar: “Small Business and Entrepreneurship”, I.K.International Publishing House Pvt. Ltd., 2008.
5. Kotler, Keller, Koshy, Jha: “Marketing Management”, 13th Edition, Pearson Education.

Reference Book:

1. Wickham, Phillip A: “Strategic Entrepreneurship”, Pitman, UK, 1998.

Occupational Safety and Health Administration

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18HOE762	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to :

- Understand the occupational health and safety and sector specific occupational health and safety issues.
- Understand the socio-economic aspects of occupational health and safety.
- Understand the health screening measures.
- Understand the legal Provisions on Occupational Health and Safety.
- Understand the participatory Research and Occupational Health.

Syllabus

Module – I

Introduction to Occupational Health and Safety: Definition and Context of OHS, Objectives and Principles of OHS, Workplace and Health Occupational Health, Hygiene and Ergonomics.

Sector Specific Occupational Health and Safety Issues: Health and Safety Risks in Mining, Health Hazards in Electronic Industry, Health Hazards in Food Processing Industry, Health Hazards in Other Industries. **07 Hours**

Module – II

Socio-Economic aspects of Occupational Health and Safety: Women's occupational and health safety, Child labour issues in occupational health and safety, Health issues in the unorganized sector.

Basics of Preventive Techniques: Definition of Accident, Accident Analysis, Monitoring of Hazards, Reporting and Investigation of Accidents. **08 Hours**

Module – III

Health Screening Measures: Stages of Medical Examination, Occupational History, Pulmonary Function Test (PFT), Noise Induced Hearing Loss (NIHL). **07 Hours**

Module – IV

Legal Provisions on Occupational Health and Safety: Overview of existing OHS Legislations in India, The Factories Act, The Mines Act, The Workmen's Compensation Act, The Employee's State Insurance Act. **07**

Hours

Module-V

Participatory Research and Occupational Health: Philosophy of Participatory Research (PR) Analysis based on PR Methodologies Conducting Participatory Research for OHS. **07**

Hours

- Develop the ability to know the occupational health and safety.
- Have the knowledge of the socio-economic aspects of occupational health and safety.
- Demonstrate purpose of health screening measures.
- Know the legal Provisions on Occupational Health and Safety.
- Participate in Research and Occupational Health.

References:

1. International Labour Organinization. Mining: a hazardous work [Internet]. ; 2015 ([cited 2015 Feb 2]. Available from: http://www.ilo.org/safework/areasofwork/ hazardous-work/WCMS_124598/lang--en/index.htm
2. Gyekye, S.A. Workers' perceptions of workplace safety: an African perspective. Int J Occup Saf Ergon. 2006;12:31–42.Crossref | PubMed| Scopus (4)
3. Amponsah-Tawiah, K., Jain, A., Leka, S., Hollis, D., Cox, T. Examining psychosocial and physical hazards in the Ghanaian mining industry and their implications for employees' safety experience. J Safety Res. 2013;45:75–84.Crossref PubMed| Scopus (5)
4. Owiredu D. Annual chamber of mines presidential review. 83rd Annual General Meeting of the Ghana Chamber of Mines [Internet]. 2011 [cited 2014 Mar 1]. Available from:http://www.ghanachamberofmines.org.
5. Helliwell, J.F., Putnam, R.D. The social context of wellbeing. Philos Trans R Soc Lond B Biol Sci. 2004;35:1435–1446.Crossref| Scopus (550)
6. Bhagawati, B. Basics of occupational safety and health. IOSR J Environ Sci Toxicol Food Technol. 2015;9:91–94.
7. Amponsah-Tawiah, K., Dartey-Baah, K. Occupational health and safety: key issues and concerns in Ghana. Int J Bus Soc Sci. 2011;14:120–126.

National Safety Council. Injury facts. NSC, Itasca (IL); 2004.

Animation and Multimedia Engineering

Course Code	L:T:P: S	Credits	Exam marks	Exam Duration	Course Type
18HOE763	2:0:0:4	3	CIE:50 SEE:50	3 Hours	OE

Course Objectives:

This course will enable students to:

- Understand the basics of Animation.
- Understand computer animation using characters.
- Learn how to create quality animation characters.
- Learn about volume construction and action made from face, gestures.
- Understand Acting and Sketching techniques.

Syllabus

Module – I

Introduction to Animation: History of Animation, The Origins of Animation, Types of Animation, Terms used in Animation, Basic Principles of Animation.

Introduction to equipment required for Animation: Animator's Drawing Tools, Rapid Sketching and Drawing, Developing Animation Character. **07 Hours**

Module – II

Developing the characters with computer animation: Anatomy and Body Language, 2-D virtual drawing for animation.

Motion studies: : Thumbnails, sequential movement drawing, drawing for motion.

08 Hours

Module – III

Essentials and qualities of good animation characters: Three dimensional drawings
of characters.

Skills and Basic proportions: Visual and creative development of an artist, how to draw gestures, Heads, Rotation in Arcs, Key Lines, Perspective. **08 Hours**

Module – IV

Volume Construction: Balance, Muscles, Light and shade.

Shape and Action: Hands and Legs, Foreshortening, Facial expressions. **08 Hours**

Module – V

Acting and Sketching techniques: Introduction to Acting, Modeling, Sketching from Acting, Sketching from live models, Introduction to Rapid Sketching Techniques, Sketching from Memory, live action. **09 Hours**

- Recognize the basics of animation along the tools.
- Develop characters with computer animation.
- Develop 3D drawings of characters and acquire skills regarding basic level of sketching.
- Explain Foreshortening, Facial expressions.
- Develop small animation characters by using acting and sketching techniques.

Text Book:

1. Chris Patmore: "The Complete Animation course: The Principles, Practice and Techniques of Successful Animation", (Chapters 1-10), Barons Educational Series New York, 2003, ISBN-13: 978-0764123993.

Reference Books:

1. Frank Thomas, Ollie Johnston: "The Illusion of Life by Walt Disney", Abbeville Press, 1981.
2. Daniel Carter, Michael Courtney: "Anatomy for the Artist: A Comprehensive Guide to Drawing the Human Body, A Complete Guide", 2011.

E-Resources:

1. http:// www.animationmentor.com/
2. https://www.bloopanimation.com/animation-for-beginners/
3. https://robots.thoughtbot.com/css-animation-for-beginners

Computer Aided Modeling and Analysis (CAMA) Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEL77	1:0:2:0	2	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Study different element types, properties and material models for modeling various structures.
- Understand the method of analyzing the bars, beams and trusses subjected to various forces.
- Develop skills for static and dynamic analysis of simple beams and bars.
- Gaining basic knowledge of analyzing the thermal problems like conduction and convection.
- Impart the knowledge of solving problems related to Air flow in pipe and on flat plate.

Syllabus

PART - A

Study of a FEA package and modeling stress analysis of

1. Bars of constant cross section area, tapered cross section area and stepped bar. **06 Hours**
2. Trusses – (Minimum 2 exercises). **03 Hours**
3. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises). **12 Hours**

PART - B

1. Stress analysis of a rectangular plate with a circular hole
2. Stress analysis of a bracket. **03 Hours**
3. Thermal Analysis – 1D and 2D problem with conduction and convection boundary conditions (Minimum 4 exercises) **07 Hours**

4. Dynamic Analysis.
   - Fixed – fixed beam for natural frequency determination.
   - Bar subjected to forcing function.

- Fixed – fixed beam subjected to forcing function.
- Velocity Distribution of air flow on flat plate.
- Analysis of air flow in pipe. **11 Hours**

Course Outcome:

On completion of this course, students will be able to :

- Select different element types, properties and material models to the different structures being analyzed.
- Do the stress analysis of bar, truss, beam and simple mechanical structuresand validate the results with theoretical results.
- Carry out static and dynamic analysis of simple beams and bars.
- Analyze the thermal problems like conduction and convection using ANSYS.
- Carryout Air flow analysis of pipe and flat plate.

Reference Books:

1. Daryl L Logan, Thomson: "A first course in the Finite element method", 3rd Edition.
2. Hutton: "Fundaments of FEM", McGraw Hill, 2004.
3. George R. Buchanan: "Finite Element Analysis", Schaum Series.

Scheme for Examination:

One Question from Part A - 20 Marks (05 Write-up + 15 Execution) One Question from Part B - 20 Marks (05 Write-up + 15 Execution)

Viva-Voce	10 Marks
Total	**50 Marks**

Heat and Mass Transfer Laboratory

Course Code	L:T:P:S	Credits	Exam marks	Exam Duration	Course Type
18MEL78	1:0:2:0	2	CIE:50 SEE:50	3 Hours	FC

Course Objectives:

This course will enable students to :

- Understand the modes of heat transfer.
- Know the laws of heat transfer.
- Study the applications of fins and heat exchangers in automobiles and industries.
- Determine the performance of refrigeration and air conditioner.

Syllabus

PART-A

1. Determination of Thermal Conductivity of a Metal Rod.
2. Determination of Effectiveness on a Metallic fin.
3. Determination of Heat Transfer Coefficient in a free Convection on a vertical tube.
4. Determination of Heat Transfer Coefficient in a Forced Convention Flow through a Pipe.
5. Determination of Emissivity of a Surface.

PART-B

1. Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
2. Experiments on Condensation of Vapour.
3. Performance Test on a Vapour Compression Refrigeration.
4. Performance Test on a Vapour Compression Air – Conditioner.
5. Experiment on Transient Conduction Heat Transfer.

Course Outcomes:

On completion of this course, students will be able to :

- Gain the skills in the experimental measurement of heat and mass transfer processes.
- Know and solve the problems on modes of heat transfer.
- Design vapor compression refrigerator and air conditioner based on interpretation of experimental data.

Scheme for Examination:

One Question from Part A - 15 Marks (05 Write-up + 10 Execution) One Question from Part B - 25 Marks (05 Write-up + 20 Execution)

Viva-Voce	10 Marks
Total	**50 Marks**

Eighth Semester B.E. - Syllabus

Phase	Activity	Credits
II	Design, Theoretical/experimental investigation and Mid-term seminar to review the progress of the work and documentation (Mid term report).	4
III	Completion of the project work, participation in the project exhibition, Submission of project re- port Final Internal seminar and demonstration, Publications.	4
	Evaluation and Viva-voce	**5 + 5**

Program Educational Objectives (PEOs)

The graduates of Mechanical Engineering are expected to fulfill the following PEOs after a few years of their graduation.

PEO 1	Graduates in Mechanical Engineering will apply the basic technical knowledge for design and analysis.
PEO 2	Graduates in Mechanical Engineering will exhibit creative and innovative skills.
PEO 3	Graduates in Mechanical Engineering will demonstrate good communication skills, dynamic leadership qualities with concern for environmental protection.
PEO 4	Mechanical Engineering graduates will be capable of pursuing higher studies, take up research and development work blended with ethics and human values.
PEO 5	Graduates in Mechanical Engineering will have the ability to become entrepreneurs thereby switching over from responsive engineering to creative engineering.

Program Outcomes (POs)

PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and Mechanical Engineering principles to the solution of complex problems in Mechanical Engineering.
PO2	**Problem Analysis:** Identify, formulate, research interpretation, and analyze complex Mechanical Engineering problems reaching substantiated conclu- sions using first principles of mathematics and engineering sciences.
PO3	**Design/Development of solutions:** Design solutions for complex Mechani- cal Engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental consider- ations.
PO4	**Conduct investigations of complex problems:** Use research-based knowl- edge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions related to Mechanical Engineering problems.

PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, re- sources, and modern engineering tools such as CAD, CAM, CIM and FEM including prediction and modelling to complex Mechanical Engineering ac- tivities with an understanding of the limitations.
PO6	**The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional Mechanical Engineering practice.
PO7	**Environment and Sustainability:** Understand the impact of the profes- sional Mechanical Engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable de- velopment.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and re- sponsibilities and norms of the Mechanical engineering practice. .
PO9	**Individual and Teamwork:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex Mechanical en- gineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and Finance:** Demonstrate knowledge and under- standing of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life- long learning in the broadest con- text of technological change.