SEMESTER : VII
COURSE CODE : 16ME401

TITLE OF THE COURSE : CONTROL ENGINEERING
L: T/A: P: C : 3: 0: 0: 3

Course Objectives

The study would enable the student to learn

- Mathematical Modeling, of mechanical and electromechanical control systems
- Characteristics and performance of feedback systems: transient and steady state response of lower order systems
- Stability analysis of feedback systems using Routh- Hurwitz criterion, root locus method, stability in frequency domain using polar plots, bode plots, performance specifications
- Basic concepts of digital control systems.

Course Outcomes

- Demonstrate an understanding of the fundamentals of (feedback) controlsystems.
- Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.
- Express and solve system equations in state-variable form (state variable models).
- Apply root-locus technique to analyze and design control systems.

Module I: Introduction to Automatic Control Systems 10L Hrs

Concept of automatic controls, Examples of control systems, open and closed loop systems, concept of feedback, requirements of an ideal control system.

Mathematical Modeling Introduction, Review of Laplace transforms, Transfer functions, Transfer function Models, Mechanical systems (both translation and rotational), Problems on Transfer functions. Electrical Analog of mechanical systems: Force-voltage, Force-current analogies, Models of thermal and hydraulic systems. Block diagrams and signal flow graphs: Block representation of system elements, reduction of block diagrams. Signal flow graphs: Mason's gain formula.

Module II : System Response 09L Hrs

Introduction, Transient & Steady state response analysis ,Standard test inputs, First orderand second order system response to unit step, ramp inputs, concept of time constant and its importance in speed of response. Steady State Error, Static and Dynamic Error Constants. System stability, Routh-Hurwitz Criterion.

Module III: Stability, R-H criterion, Root Locus 08L Hrs

The root locus concept, Guidelines for sketching root loci, Selected illustrative root loci.

Module IV: Frequency response –Polar, Nyquist, Bode Diagrams 09L Hrs

Frequency response –Polar, Nyquist, Bode Diagrams:Polar plots, Nyquist Stability Criterion, Stability analysis, Relative stability concepts, Phase and gain margin, M&N circles.

Frequency response analysis using Bode plots:Bode attenuation diagrams, StabilityAnalysis using Bode plots, Simplified Bode Diagrams.

Module V: Introduction to P-I-D controllers **08L Hrs**

Introduction to P-I-D controllers: Types of controllers-Proportional, Integral, Proportional Integral, Proportional Integral Differential controllers.

Analysis of control systems in state space: Introduction to state concepts, state-space representation of transfer-function systems, controllability and observability.
Introduction to Digital control systems: Introduction, Advantages offered by digitalcontrols.

Text books

1. Katsuhiko Ogata, Modern Control Engineering, Second edition, Prentice Hall of India Private Ltd, NewDelhi, 1995.
2. Nagrath I J and Gopal .M, Control Systems Engineering, FirstEdition,Wiley and sons, 1985.

Reference books

1. Benjamin C Kuo, Automatic Control System, 7thEdition, Prentice Hall of India, Private Ltd, New Delhi, 1993.
2. Richard .C. Dorf and Robert.H.Bishop, Modern Control System Engineering,Addison Wesley, 1999.

SEMESTER VII
COURSE CODE : 16ME402

TITLE OF THE COURSE : OPERATION RESEARCHL: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

1. To appropriately formulate Linear Programming models for service and manufacturing systems, and apply operations research techniques and algorithms to solve these LP problems.
2. To interpret and apply the results of an operations research model.
3. Solve specialized linear programming problems like the transportation and assignment problems
4. Solve network models like the shortest path, minimum spanning tree, and maximum flow problems.

Course Outcomes

1. Formulate and solve Linear Programming Problems
2. Determine performance measures for basic queuing problems using appropriate closed form equations
3. Work in teams to complete projects or case studies
4. have a knowledge of logical issues

Module I: Introduction & Linear Programming Problem 09L Hrs

Origin of Operation Research, Historical Standpoint, Methodology, Different Phases, Characteristics, Scope and Application of Operations Research.

Requirement of LP, Basic Assumptions, Formulation of LP, General Statement of LP, Solution techniques of LP: Graphical Methods, Analytical Methods: Simplex, Big M and Two Phase, Sensitivity Analysis, Primal and Dual Problems, Duality in linear programming problems, dual simplex method.

Module II : Transportation & Assignment 09L Hrs

Transportation Problems definition, Linear form, Solution methods: North west corner method, least cost method, Vogel's approximation method. Degeneracy in transportation, Modified Distribution method, Unbalanced problems and profit maximization problems. Transshipment Problems.

Assignment problem - Introduction, Mathematical formulation of the problem, Hungarian assignment method only, special cases in assignment problems, Travelling sales man Problem.

Module III: Queueing theory & Inventory Control 09L Hrs

Queueing theory - Basic structure of queuing systems, elements of queuing theory, Kendall's Notation,Operating characteristics of a queuing system, roles of the Poisson and exponential distributions, classification of queues basic results of M/M/1: FIFO systems, extension to multi-server queues.

Inventory Control - classification, Different cost associated to Inventory, Economic order quantity, Inventory models with deterministic demands.

Module IV: Game Theory **09L Hrs**

Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods.
CPM & PERT- project scheduling, critical path calculations, Crashing

Module V: Replacement & Decision Theory **08L Hrs**

Replacement Theory: Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.
Decision Theory: Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, MiniMax criterion, savage MiniMax regret criterion, hurwicz criterion, Decision tree.

Text books

1. Hamdy. A. Taha, "Operations Research an Introduction", Pearson Education, 17th Edition, 2002.
2. Ravindran A, Philips D.T &Solbery.J.J, Operations Research: Principles and practice, John Wiley & Sons, New York, 1987.
3. S.D Sharma, "Operation Research", KedarNath and Ram Nath - Meerut, 2008.

Reference books

1. Joseph.G.Ecker& Michael KupperSchimd, Introduction to operations Research,John Wiley & Sons, 1988.
2. KantiSwarup, Gupta.P.K. & Man Mohan, Operations Research, S.Chand& Sons,2005.
3. Gillet.B.E., Introduction to Operations Research - A Computer oriented algorithmic approach, McGraw Hill, 1987.

SEMESTER VII
COURSE CODE : 16ME403

TITLE OF THE COURSE : HYDRAULICS AND PNEUMATICSL: T/A:P: C : 2 : 0 : 2 : 3

Course Objectives

The course will enable the students to:

- Appreciate the fundamental principles of Fluid Mechanics
- Study of working principle of various components used in hydraulic and pneumatic systems.
- Select different components used in hydraulic and pneumatic systems.
- Design of hydraulic and pneumatic circuits.
  Understand industrial applications of hydraulic and pneumatic circuits.

Course Outcomes

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

- Understanding operating principles and constructional features of hydraulic andpneumatic systems.
- Knowledge with selection of hydraulic / pneumatic components
- Understanding of designing and layout of Hydraulic Power package and troubleshooting.

Module I: Fluid power principles and hydraulic pumps 09L Hrs

Introduction to Fluid power- Advantages and Applications- Fluid power systems – Typesof fluids-Properties of fluids – Basics of Hydraulics – Pascal's Law- Principles of flow – Friction loss- Work, Power and Torque. Problems Sources of Hydraulic power: Pumping Theory – Pump Classification- Construction, Working, Design, Advantages, Disadvantages, Performance, Selection criterion of Linear, Rotary- Fixed and Variable displacement pumps-Problems

Module II : Hydraulic actuators and valves 09L Hrs

Hydraulic Actuators: Cylinders– Types and construction, Application, Hydrauliccushioning - Hydraulic motors Control Components: Direction control, Flow control andPressure control valves- Types, Construction and Operation- Servo and Proportionalvalves - Applications – Types of actuation. Accessories: Reservoirs, Pressure Switches-Applications- Fluid Power ANSI Symbols - Problems

Module III: Hydraulic systems 09L Hrs

Accumulators, Intensifiers, Industrial hydraulic circuits- Regenerative, Pump Unloading, Double pump, Pressure Intensifier, Air-over oil, Sequence, Reciprocation, Synchronization, Fail-safe, Speed control, Hydrostatic transmission, Electro hydraulic circuits, Mechanical Hydraulic servo systems

Module IV: Pneumatic systems 09L Hrs

Properties of air– Perfect Gas Laws- Compressors- Filter, Regulator, Lubricator, Muffler, Air control Valves, Quick Exhaust valves, Pneumatic actuators, Design of pneumatic circuit cascade method- Electro pneumatic circuits, Introduction to Fluidics, Pneumatic logic circuits.

Module V: Trouble shooting and applications **08L Hrs**

Installation, Selection, Maintenance, Trouble Shooting and Remedies in Hydraulic and Pneumatic systems. Design of hydraulic circuits for Drilling, Planning, Shaping, Surface grinding, Press and Forklift applications. Design of Pneumatic circuits for a Pick and Place application and tool handling in a CNC machine. - Low cost Automation – Hydraulic and Pneumatic power packs- case studies.

Text books

1. Majumdar, S.R., "Oil Hydraulics Systems- Principles and Maintenance", Tata McGraw Hill,2001
2. Majumdar, S.R., "Pneumatic Systems – Principles and Maintenance", Tata McGraw Hill, 2007.

Reference books

1. Anthony Esposito, "Fluid Power with Applications", Prentice Hall, 2009.
2. Shanmugasundaram.K, "Hydraulic and Pneumatic Controls", Chand & Co, 2006.
3. Dudelyt, A Pease and John J Pippenger, "Basic Fluid Power", Prentice Hall, 1987.
4. Srinivasan.R, "Hydraulic and Pneumatic Controls", Vijay Nicole Imprints, 2008.
5. Joji.P, "Pneumatic Controls", John Wiley & Sons India, 2008

SEMESTER VII
COURSE CODE : 16ME421

TITLE OF THE COURSE : RAPID MANUFACTURING TECHNOLOGIESL: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

1. To provide knowledge of methods for the manufacturing of prototypes from computer based models
2. To understand the entire process of direct manufacturing from the creation of computer based models to their physical realization
3. To understand the various methods of manufacturing and their merits, demeritsand applications
4. To impart students to convert CAD models into real life engineering components

Course Outcomes

1. Able to understand the various rapid prototyping, rapid tooling technologypertaining to RPT
2. Able to gain knowledge to select appropriate technology for product development
3. Able to use tools to explore rapid prototyping techniques and CAD modelling software

Module I: Introduction 08L Hrs

Introduction- Need for the compression in product development, Historical development, Fundamentals of RP, Advantages and Classification of RP systems. Process chain, RP Data Formats, Information flow in an RP system.

Module II : Liquid based rapid prototyping systems 08L Hrs

Stereo lithography Apparatus (SLA): Principle, process parameters, process details,machine details, products, Advantages, Limitations and applications. Solid ground curing (SGC): Principle, process parameters, process details, machine details, products, Advantages, Limitations and applications.

Module III: Solid based rapid prototyping systems 08L Hrs

Fused Deposition Modelling (FDM): Principle, process parameters, process details,machine details, products, Advantages, Limitations and applications. Laminated ObjectManufacturing (LOM):Principle, process parameters, process details, machine details,products, Advantages, Limitations and applications. Ballistic Particle Manufacturing(BPM): Principle.

Module IV: Powder based rapid prototyping systems and concept modellers 10L Hrs

Selective laser sintering (SLS): Principle, process parameters, process details, machine details, products, Advantages, Limitations and applications. Three dimensional Printing (3DP): Principle, process parameters, process details, machine details, products, Advantages, Limitations, applications. Laser Engineering Net Shaping (LENS) - Principle. Concept

modellers like thermal jet printers, Sander’s model maker, GenisysXs 3D printers, JP system 5, Object Quadra system.

Module V: Rapid Tooling and Applications **10L Hrs**

Introduction to rapid tooling: Direct soft tooling- casting molds, Direct AIM, composite tooling. Indirect soft tooling- spray metal molding, silicon rubber molds, Castable resin and ceramic molds. Direct hard tooling-rapid tool, Laminated metal tooling, DMLS tooling. Indirect hard tooling- 3D keltool, ED electrodes, Ecotool, copy milling. Applications: Application-Material Relationship, Applications in Design, Applications in Engineering, Analysis and Planning. Application of Rapid prototyping in biomedical, automotive, aerospace, jewellery and coin industries.

Text books

1. C. K.Chua, K. F.Leong and C. S.Lim, Rapid prototyping: Principles and applications, World Scientific Publishers, 2003.
2. Ramesh S " Rapid prototyping" ANE Publications, New Delhi.
3. D. T.Pham and S. S.Dimov, Rapid manufacturing, Springer-Verlag, London,2001.

Reference books

1. Andreas Gebhardt, Hanser , Rapid prototyping, Gardener Publications, 2003.
2. L.W.Liou, F.W. Liou, Rapid Prototyping and Engineering applications: A tool box for prototype development, CRC Press, 2007.
3. K. Kamrani, E. A. Nasr, Rapid Prototyping: Theory and practice, Springer, 2006.
4. Terry Wohlers, "Wohlers Report 2001", Wohlers Associates, 2008.
5. Kenneth G. cooper, Rapid prototyping technology: Selection and application,CRC Press, 2001.

SEMESTER VII
COURSE CODE : 16ME423

TITLE OF THE COURSE : COMPUTATIONAL FLUID DYNAMICSL: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

The course will enable the students to:

- Introduce Governing Equations of viscous fluid flows
- Introduce numerical modelling and its role in the field of fluid flow and heat transfer
- Enable the students to understand the various discretization methods, solution procedures and turbulence modelling.
- Create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

Course Outcomes

After completion of the course student would be able to

- Create numerical modelling and its role in the field of fluid flow and heat transfer.
- Use the various discretization methods, solution procedures and turbulence modelling to solve flow and heat transfer problems.

Module I: Governing equations and boundary conditions 08L Hrs

Basics of computational fluid dynamics – Governing equations of fluid dynamics – Continuity, Momentum and Energy equations – Chemical species transport – Physical boundary conditions – Time-averaged equations for Turbulent Flow – Turbulent–Kinetic Energy Equations – Mathematical behaviour of PDEs on CFD - Elliptic, Parabolic and Hyperbolic equations.

Module II : Finite difference and finite volume methods for diffusion 09L Hrs

Derivation of finite difference equations – Simple Methods – General Methods for first and second order accuracy – Finite volume formulation for steady state One, Two and Three – dimensional diffusion problems –Parabolic equations – Explicit and Implicit schemes – Example problems on elliptic and parabolic equations – Use of Finite Difference and Finite Volume methods.

Module III: Finite volume method for convection diffusion 10L Hrs

Steady one-dimensional convection and diffusion – Central, upwind differencing schemes properties of discretization schemes – Conservativeness, Boundedness, Transportiveness, Hybrid, Power-law, QUICK Schemes.

Module IV: Flow field analysis 09L Hrs

Finite volume methods -Representation of the pressure gradient term and continuity equation – Staggered grid – Momentum equations – Pressure and Velocity corrections – Pressure Correction equation, SIMPLE algorithm and its variants – PISO Algorithms.

Module V: Turbulence models and mesh generation 08L Hrs

Turbulence models, mixing length model, Two equation (k-Є) models – High and low Reynolds number models – Structured Grid generation – Unstructured Grid generation –Mesh refinement – Adaptive mesh – Software tools

Text books

1. Versteeg, H.K., and Malalasekera, W., “An Introduction to Computational Fluid Dynamics: The Finite Volume Method”, Second Edition Pearson Education Ltd. 2007.
2. Ghoshdastidar, P.S., "Computer Simulation of flow and heat transfer", Tata McGraw Hill Publishing Company Ltd., 1998.

Reference books

1. Patankar, S.V. "Numerical Heat Transfer and Fluid Flow, Hemisphere" Publishing Corporation, 2004.
2. Chung, T.J. "Computational Fluid Dynamics", Cambridge University, Press, 2002.
3. Ghoshdastidar P.S., "Heat Transfer", Oxford University Press, 2005
4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and HeatTransfer", Narosa Publishing House, New Delhi, 1995.

SEMESTER VII
COURSE CODE : 16ME427

TITLE OF THE COURSE : AUTOMOBILE ENGINEERINGL: T/A:P: C : 3 : 0 : 0 : 3

Course Objectives

The course will enable the students to:

- Understand basics of Automobile Engineering & various Automotives system.
- Understand vehicle layout, vehicle specifications & important of automobile.
- Make the student conversant with drive train & transmission.
- Make the student conversant with Suspension, Steering, Brakes systems & Tyre Wheel assembly.
- Make the student conversant with Vehicle Maintenance & Garage Practice.
- Understand the various Automobile Electrical System, Vehicle performance &their safety.

Course Outcomes

After completion of the course student would be able to

- Handle technical & management problems in automotive industries.
- Diagnosis the faults of automobile vehicles.
- Understand various transmission systems, Suspension, brakes, Vehicle Performance, Vehicle Safety.

Module I: Introduction to Automobile Engineering 07L Hrs

Automobile history and development, current scenario in Indian auto/ ancillary industries, Role of the automobile industry in national growth, Classification, types of chassis layout with reference to power plant locations and drive, Vehicle frames, Various types of frames. Constructional details, Unitised frame body construction, Loads acting on vehicle frame, details of chassis material.

Module II : Drive Train & Transmission 09L Hrs

Classification of clutches, Single plate & with dual flywheel effect, Multi plate, Cone, diaphragm spring, Centrifugal, Clutch materials, Clutch plate, Electromagnetic, vacuum operated, Necessity of gear box, Manual gear box-Constant mesh, Sliding mesh, Synchromesh, Epicyclic, fluid flywheel, Torque convertor, Continuous variable transmission, Electronic transmission control, overdrive, Propeller Shaft, Universal Joint, Differential and final drive, hotchkiss drive, torque tube drive.

Module III: Front & Rear Axle, Steering System,Suspension & Brakes System 10L Hrs

Axle: Purpose and requirement of front & rear axle, live and dead axles types & arrangement, types of loads acting on rear axles, full floating, three quarter floating and semi floating rear axles.

Steering System: Steering mechanism, steering geometry, cornering force, slip angle, scrub radius, steering characteristic, steering linkages & gearbox, power steering, collapsible steering, reversibility of steering, four wheel steering.

Suspension: Sprung and unsprung mass, types of suspension linkages, types of suspension

springs- leaf, coil, air springs, hydro gas, rubber suspension, interconnected suspension, self levelling suspension (active suspension), damping and shock absorbers

Brakes: Types of brake systems - drum, disc, operation-mechanical, hydraulic, air brakes,servo and power braking, hand brake, ABS.

Module IV: Vehicle Performance, Safety & Modern Trends 08L Hrs

Vehicle performance parameters, road resistance, traction and tractive effort, power requirement for propulsion, road performance curves(Numerical treatment expected), Stability of vehicles, roll over safety regulations, Vehicle safety- active, passive safety, airbags, seat belt, Vehicle interior and ergonomics, comfort, NVH in automobiles, electrical car layout, hybrid vehicles, Solar operated vehicle, measuring instruments for wear, speed, acceleration, vibration, noise.

Module V: Electrical System & Vehicle maintenance 08L Hrs

Batteries: Principles and construction of lead-acid battery, characteristics of battery,rating capacity and efficiency of batteries, various tests on battery condition, chargingmethods.

Lighting System & Accessories: Insulated & earth return systems, positive & negative earth systems, electrical fuel pump, speedometer, fuel, oil & temperature gauges, horn, wiper system, trafficator, sensors and actuators, electronic control unit, traction control devices.

Vehicle maintenance Schedule maintenance chart of a vehicle, maintenance, overhauling & servicing of chassis, clutch, gear box, propeller shaft, differential, axles, steering system, wheels, tyres, suspension, brakes system, electrical system.

Text books

1. William H. Crouse., "Automotive Mechanics", Tata McGraw Hill Publishing House.
2. Automobile Electrical Equipment -P. S. Kohali, Tata McGraw Hill Publishing House.

Reference books

1. K. Newton and W. Seeds, T.K. Garrett, "Motor Vehicle", 13thEdition, Elsevier publications.
2. Hans Hermann Braess, Ulrich Seiffen, "Handbook of Automotive Engineering ", SAE Publications
3. Narang G. B. S , " Automobile Engineering", S. Chand and Company Ltd.
4. Dr.Kirpal Singh, "Automobile Engineering", Volume 1, Standard Publishers distributors.

SEMESTER VII
COURSE CODE : 16ME471

TITLE OF THE COURSE : CONTROL ENGINEERING
LABORATORYL: T/A:P: C : 0 : 0 : 4 : 2

Course Objectives

The study would enable the student to learn

- To understand the experimental approach for determination of step responseof first and second order systems
- To understand the experimental approach to identify frequency response of second order system and evaluation of frequency domain specification using Matlab
- To plot root locus plot for given open loop transfer functions.
- To determine gain and phase margin through Bode plots.
- To examine the stability of a closed loop unity feedback system with open loop transfer function.

Course Outcomes

- Students will have the knowledge on MATLAB tools.
- Students will be able to write Matlab programming for the analysis of LTI system.
- Students able to use concepts Differential equations - using Laplace transforms to solve them, Poles and zeroes of a transfer function and impedance ands – impedances also students will be able to analyze Network functions.
- Students able to do System identification and analyze the system for time and frequency response.

LIST OF EXPERIMENTS

MAT LAB Basics

- Introduction: Staring MATLAB, elementary functions, commands and variables
- Expressions: Scalar and vector expressions and their evaluations
- Arrays: Creation and manipulations of array, built in functions for arrays.
- Scripts and functions: Creation and execution of script files and function files.
- Programming in MATLAB: Loops and conditional statements.

1. Working on different MatLab commands to understand MATLAB usage.
2. Simulation of a typical first order & second order system and determination of step response of the system using MatLab.
3. Determine the frequency response of second order system and evaluation of frequency domain specifications using MatLab.
4. Obtain the unit impulse response, ramp response & sinusoidal input response of thesecond order system using MatLab.
5. Obtain the root locus plot for the given open loop transfer function G(s) H (s). Determine the closed loop poles that have the damping ratio 0.5. Find the gain valueK at this point.
6. Obtain the gain margin and Phase margin for a given transfer function by drawingBode plots and verify the same using MatLab.

7. Find the find the value of gain K for a specified Gain margin and Phase margin for agiven transfer function by drawing Bode plots using MatLab.
8. Examine the stability of the closed loop unity-feedback system with the open loop transfer function, draw the Nyquist plot.
9. Using MatLab SIMULINK, simulate the three linear systems to compare their step responses.
10. Using MatLab SIMULINK, simulate the feedback systems.

UNIVERSITY PRACTICAL EXAMINATION
Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]
SPLIT UP OF INTERNAL MARKS

Record Note	= 10 marks
Conduction of experiments	= 10 marks
Internal Assessment	= 20 marks
Total	= 40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

SEMESTER VII
COURSE CODE : 16ME481

TITLE OF THE COURSE : PROJECT WORK STAGE
- IL: T/A:P: C : 0 : 0 : 4 : 2

Course Objectives

1. To develop the work practice in students to apply theoretical and practical tools/techniques
2. To improve the professional competency
3. To improve research aptitude by touching the areas which otherwise not covered by theory or laboratory classes.
4. To solve real life problems related to industry and current research.

Course outcomes

1. Solving of real time problems not necessarily new line of enquiry, but shows that student has interest in research and synthesising skills in producing a contribution to knowledge.
2. Builds competency and research aptitude.

The project work for B.Tech consists of Project Work Stage - I and Project Work Stage - II. Project Work Stage - I is to be undertaken during B.Tech VII semester and Project Work Stage - II, which is generally a continuation of Project Work Stage - I and is to be undertaken during B.Tech VIII semester.

GENERAL SUGGESTIONS AND EXPECTATIONS

The Project Work is by far the most important single piece of work in the programme. It provides the opportunity for student to demonstrate independence and originality, to plan and organize a large Project over a long period and to put into practice some of the techniques student have been taught throughout the course. The students are advised to choose a Project that involves a combination of sound background research, a solid implementation, or piece of theoretical work, and a thorough evaluation of the Project's output in both absolute and relative terms. Interdisciplinary Project proposals and innovative Projects are encouraged and more appreciable.

It is good to try to think of the Project as a deliverable at reviews rather than an effort to deliver a fully functioning 'product'. The very best Projects invariable covers some new ground, e.g. by developing a complex application which does not already exit, or by enhancing some existing application or method to improve its functionality, performance etc.

A straightforward implementation Project is acceptable, but student must appreciate that it is unlikely to gain high marks, regardless of how well it is done and its usage. Likewise,

Projects which are predominantly survey reports, unless they are backed up with experimentation, implementation, on theoretical analysis, e.g. for performing an objective comparison of surveyed methods, techniques etc. pure survey reports with no supporting implementation or theory, are not acceptable.

1. Undergraduate students are to decide on the Project Work Stage - I and Project Work Stage - II Project with their proposal and Project Supervisor during the month of July/August with a Synopsis consisting of about three chapters –
    a. Introduction,
    b. Literature Review
    c. Methodology which should highlight the deliverables.
2. In Case of re-reviews, any number of re-reviews can happen depending on the discretion of the committee and it should happen within the prescribed time.
3. If the student fails to attend, the Supervisor refuses to endorse the student's work.The committee can invite Head of the Department who is empowered to resolve among further matters.
4. If the work of the candidate is found to be insufficient and plagiarism, the committee and Head of the Department will decide the further process.
5. Head of the Department can initiate further steps to ensure the smooth implementation as deems appropriate of guidelines.

- The idea for student's Project may be a proposal from a faculty member orstudent's own, or perhaps a combination of the two.
- All B. Tech projects are to be done in the Institute. For industry specified projects, students will be permitted to spend 1-2 weeks in the industry on recommendationby the supervisor. The number of students per batch should be 4.
- The End Semester evaluation shall be based on the report submitted and a viva- voce exam by committee comprising of the head of the department, project supervisor and an external examiner.

The Departmental Committee (DC) consists of HOD, Supervisor and two senior experts in the department. The committee monitors the progress of Project Work. The DC is constituted by the Principal on the recommendations of the department Head
Student shall register for the Project work with the approval of Departmental Committeein the B.Tech VII semester and continue the work in the B.Tech VIII semester too. The Departmental Committee (DC) shall monitor the progress of the project work. In B.TechVII semester, Stage - I of the Project Work is to be completed. A team has to identifythe topic of work, collect relevant Literature, preliminary data, implementation tools / methodologies etc., and perform a critical study and analysis of the problem identified. They shall submit status report in addition to oral presentation before the DepartmentalCommittee for evaluation.

A candidate shall continue the Project Work in B.Tech VIII semester (Stage - II) and submit a Project report at the end of Stage - II after approval of the Departmental Committee. During Stage - II, the teams shall submit status report in addition to oral presentation before the DC. The DC shall evaluate the project for internal marks (Stage - I & II) based on the progress, presentations and quality of work.

Course Code: 17VT104 Total Hours :45 hrs	PRODUCTION TECHNOLOGY - 1	L	T	P	C
			-	-	3
Course Objectives	The objective of this course is to make the students : 1. Importance of Safety precautions 2. Understand usage of fitting tools 3. Understand tool nomenclature and metal cutting theory 4. Comprehend various drilling operations including counter				
Course outcomes	Students after the completion of this course will be able to : 1. Explain basic machine tools for various machining operations 2. Understand machining parameters on surface finish, type of operations, production and tool life 3. Interpret type of tools for suitable machining operations based on				

Module 1

Safety - Causes of accidents: Lack of interest, poor judgment, lack of confidence, lack of knowledge, overconfidence, poor physical fitness, personal problem, improper working environment. General Safety Precautions. **08 hrs**

Module 2

Manual Metal working: Metal working hand tools, devices, specification, types and applications- Work bench, vices, files, hammer, hacksaw, chisels, spanners, screw driver, scrapers. **08hrs**

Module 3

Metal cutting Theory: Metal cutting theory-speed, feed, depth of cut, shear plane Nomenclature of single point cutting tool-significance of positive, negative and zero rake angles different tool angles. **09 hrs**

Module 4

Drilling - Drills: Nomenclature of twist drill- types of drills-material of drill - sharpening of drills - drill size designation - designation drill according to Indian standard system(IS:599). Drilling machines: Different types of drilling machines, specification of a drilling machine, work holding devices, Tool holding devices, drilling machine mechanism, drilling machine operations, drilling time calculation. **10 hrs**

Module 5

Counter boring, counter sinking, reaming and tapping. Counter boring: Importance, Types of counter bores. Reamer: Hand reamer, machine reamer, reaming operation. Taps: Different types of taps, nomenclature of taps, tapping operation. Die:Types of Dies -solid die–split die-die stock-die passing operation. Lathe: Parts of Lathe, Types of lathe, lathe operations.

10hrs

Text books

1.Serope Kalpak Jian; Steven R. Schmid (2010), Manufacturing Engineering and Technology, 6th Edition, Publisher: Prentice Hall, ISBN-10 0-13-608158-1, ISBN- 13 978-0-13-608158-5.
2.P.N. Rao. (2009), Manufacturing Technology – Foundry, Forging and Welding, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference books

1.M P Groover (2007), Fundamentals of Modern manufacturing (materials, processes and systems) third edition, Wiley publications, ISBN-978-0-471-74485-6, USA

Course code: 17VT105 Total hours: 45	QUALITY MANAGEMENT-I	L	T	P	C
			-	-	3
Course objectives	The objective of this course is to make the students : 1. Understand terminology in Metrology and usage of measurements in industry 2. Familiarize with different measuring instruments and their working principles 3. Familiarize about marking and				
Course outcomes	Students after the completion of this course will be able to : 1. Understand the various terms and				

Module 1

Introduction to Metrology: Meaning of Metrology - objective of metrology, Importance of inspection in Industry– Quality Control, Units and Measurements – Definitions – Supplementary Units - S.I units The Do's and Don'ts, Precision vs. Accuracy. **10 hrs**

Module 2

Linear Measurements: Steel rules - steel tape, Types of Calipers: types of joints, legs – Transfer calipers –, Principle of Vernier, Vernier - Least count 0.1, 0.5 and 0.02, Vernier caliper- Vernier depth gauge- Vernier height gauge- Gear tooth Vernier, Micrometer – Screw thread micrometer – Dial indicating Micrometer – V anvil micrometer, Error

on micrometer, **08 hrs**

Module 3

Marking and Marking Tool: Purpose of marking, Systems of marking: rectangular - polar- Jenny calipers, Tools for marking: surface plate - marking stand -scriber - divider - Vblock - angle plate – trammel.Bore measuring instruments: Bore gauge, Telescopic gauge, Hemi-spherical gauge. **10 hrs**

Module 4

Gauges: Classification: According to type - standard and limit, according to purpose - workshop - inspection – reference according to the elements to be checked- gauge for checking holes - shafts - tapers - threads – forms, Plug gauge - snap gauge - taper gauge - thread gauge - profile gauge - radius gauge - feeler gauge - plate and wire gauge, Material for gauge: requirements of good gauge material – HCS case hardened steel) cast steel -plated gauges - Invar - Elinvar -other alloy steels.
10 hrs

Module 5

Slip gauge: Description of slip gauge - number of blocks in standard sets – wringing property - grades - reference grade - inspection grade - calibration grade - workshop grade, Manufacturing of slip gauges-heat treatment to make wear resistant seasoning to ensure stability- lapping at 200^{0} C. **07 hrs**

Text Books:

1. Beckwith Marangoni and Lienhard, “Mechanical Measurements”, Pearson Education, 6th Edition, 2006.

2. A. K Sawhney, “A course in Mechanical Measurements and Instrumentation”, Dhanpat Rai Publications.

3. Mechanical and Industrial measurements - R.K Jain

Reference books

1. Alan S. Morris, “The Essence of Measurement”, Prentice Hall of India, 1997

2. Beckwith T.G, and N. Lewis Buck, “Mechanical Measurements”, Addison Wesley, 1991

3. Ernest O. Doebelin, “Measurement Systems Applications and Design”,5th Ed., McGraw Hill Book Co.

4. N. V. Raghavendra and Krishnamurthy, “Engineering Metrology and Measurement”, Oxford University Press.

Course Code17VT106 Total Hours : 90	**ENGINEERING DRAWING AND CAD-I**	**L**	**T**	**P**	**C**
			-		**6**
Course objective	The objective of this course is to make the students : 1. Understand the importance of engineering drawing and application of computer. 2. use engineering drawing instruments competently 3. Competency to write engineering script. Understand the importance of SP46 standards 4. Ability to construct &understand standard geometrical shapes. 5. In depth practice of pictorial projection				
Course outcome	Students after the completion of this course will be able to: 1. Analyze and design the basic electronic circuits containing semiconductor devices. 2. Identify the need of Integrated Circuits and use the mineralizing circuit applications. 3. Analyze and implement basic Digital				

Module -1

Introduction - engineering drawing: Importance of engineering drawing & role of drawing in engineering education, engineering drawing equipment's, Basic drawing instruments T-square, Set Square. Compass, dividers, mini drafter pro-circles, Drawing board & pencil. Introduction to computer aided drafting Importance of computer aided drafting, menu

selection, begin new drawing editing existing menu selection practice on computers. Basics of engineering drawing: Features' of lettering (Selection of suitable size of letters & numbers as per SP 46). Introduction to CAD. By using screen menu, tool bar &cursor menu, button menu Practice on computer. Exercises: Writing notes in engineering script. Introduction & explanation on utility commands, Help, End, Quit, Save, Limits, Units, function key & Drafting setting practice. Drawing sheet sizes, (as per SP 46).Scale, full scale, reduced scale, Enlarged scale (as per SP 46) lines (As per SP 46). Introduction to entity draw commands Line, absolute, relative, polar co-ordinates, direct distance entry, Points, Undo, redo, and Move. Practice on computers Title block & sheet layout, (As per SP 46) **30 Hrs**

Module -2

Dimensioning: Importance of dimensioning, Elements of dimensioning &general rules of dimensioning size of arrowhead , placing of dimension line ,projection line , value of dimension &leader lines, System &method of indicating dimensions, Arrangement of dimensions chain dimensioning, parallel dimensioning, superimposed dimensioning, combined dimensioning, superimposed dimensioning & co-ordinate dimensioning, Special indication for dimensions (dimensioning practice).

15 Hrs

Module -3

Geometric construction: Arc joints, by using compasses, exercises, Line joints. [Circle, arc, polygon ellipse hatch Practice on computers. 1 h for computers], Terminology of different shape, Bisecting an angle ,bisecting a line, finding a center of given circle &divide a line equal and un equal Conic section Construction of ellipse. Arc intersecting method, understand about parabola& hyperbola, cycloid construction, helix construction &understand about involute, [layers, line type properties modify command erase , copy mirror ,offset Practice.

15 Hrs

Module 4

Projection: Introduction about projections. Practice on computers. [Array, rotate, scale, trim, extend, break2 h for computer] Isometric drawings, steps involved in preparing, construction of circle in isometric view isometric drawings. Practice on computer [chamfer, fillet, stretch, explode2 h for computer] Exercise on Isometric drawings. From the reference of direct isometric view Practice on computer [edit and display command, isometric snap, object snap, iso plane.

15 Hrs

Module 5

Ortho graphic projections, planes of projections, first angle projection and third angle projection, why second angle and fourth angle not used in engineering drawing, construction details of front view top view and side view in first angle projection Exercise on orthographic projection. Practice on computer, Exercise on Isometric drawings. From the reference of orthographic view, Identification of view & missing view.

15 Hrs

Note: All the drawing exercises are performed using AutoCAD.

Textbook:

1. Machine drawing - P I Varghese and K.C John
2. SP46 - BIS
3. Engineering Drawing - N.D. Bhatt
4. IS 696 - BIS
5. IS 8000 - BIS

Reference books:

1. PSG Hand book - PSG
2. CMTI Hand book

Course Code: 17VT107 Total Hours: 125	WORK SHOP-1	L	T	P	C
			--		9
Course objective	The objective of this course is to make the students : 1. Aware of safety aspects in handling of fitting tools and equipment and create different fitting joints 2. Fabricate various metal joining process
Course outcome	Students after the completion of this course will be able to : 1. Demonstrate fitting skills and create fitting joints 2. Exhibit welding, soldering &

1. Fitting: Study of fitting tools, carry out fitting work of models involving rectangular, Triangular, semi-circular and dovetail joints.
2. Welding: Study the joining process (Welding) and carry out Welding exercises of Butt joint, Lap joint, T joint and L-joint.
3. Sheet Metal: Fabricate simple shapes using sheet metal.
4. To Perform Various Operations on a Lathe Machine
5. To Perform Various Operations on a Drilling Machine

Text Books:

1. DSU Work shop manual.

Course code: 17VT108	QUALITY MANAGEMENT LAB-I	L	T	P	C
		-	-		3
Course Objectives	Students after the completion of this course will be able to: 1. Introduce the students to the need, standards and principles of measurement. 2. Introduce the students to the principles of
Course outcomes	Students after the completion of this course will be able to: 1. The purpose of this course is to provide the student with a basic understanding of the theory and practice of measurement and

1. **Calibration of Micrometer** - To calibrate the given micrometer using slip gauge, draw the calibration curve and to evaluate the errors occurred.
2. **Calibration of Vernier caliper and measurement of the given component** - To calibrate and measure the given component by using Vernier caliper.
3. **Measurements using Optical Profile Projector** – To measure the screw thread parameters of a given specimen using Optical Profile projector.
4. **Measurements using Toolmaker's Microscope** - To measure the screw thread parameters of a given specimen using Tool Maker's Microscope.
5. **Measurements of angle using Sine bar** - To determine the unknown angle of the given specimen using sine bar with the help of slip gauge.

6. **Measurements of angle using universal bevel protractor** - To determine the unknown angle of the given specimen using universal bevel protractor.
7. **Measurements of Screw thread parameters using two wire or three-wire methods** - To find the effective diameter of a given screw thread by two or three wire method.
8. **Measurements of surface roughness parameters using mechanical comparator** - To measure the various surface roughness parameters of the components using mechanical comparator (dial gauge indicator)
9. **Measurements of gear tooth profile using gear tooth Vernier caliper** - To Measure the tooth thickness of the given gear using Gear Tooth Vernier Caliper.

Text Books: DSU Metrology Manual

Course code: 17VT203	Production Technology – II	L	T	P	C
			--	--	2
Course objectives	The objective of this course is to make the students understand : 1. Manufacturing processes including casting, forging and rolling 2. Material removal processes including turning, drilling, milling & grinding 3. Non-conventional machining				
Course outcomes	After successful completion of the course, the students should be able to : 1. Comprehend the various machining processes such as turning, drilling, milling and grinding.				

Module 1

Lathe: Boring, Feed mechanism, feed gear box, Thread cutting mechanism and thread cutting operation, Taper and Taper turning, Taper turning method. **02 Hrs**

Module 2

Cutting Tool Material: Characteristics of ideal cutting tool material, cutting tool material. 02 **Hrs**

Module 3

Cutting fluids and lubricants: Properties of good cutting fluid, Types of cutting fluids, Properties of lubricants, Classification of lubricants. **02 Hrs**

Module 4

Milling: Classification of milling machines, Parts of milling machines, milling process, Milling cutters, Nomenclature of milling cutter, Cutting speed, feed and depth of cut, Work holding devices, cutter holding devices. **Grinding:** Grinding operations, Grinding machines, surface grinders, cylindrical grinders, Tool and cutter grinder.**Permanent fastening methods:** Welding, Soldering, Brazing, Rivet joints

06Hrs

Module 5

Basic health and safety, Health and safety, Protective clothing/Equipment, Hazards, Safe working practices, Methods of accident prevention, Good housekeeping practices at various areas. Fire safety, Types of fires, Rescue techniques applied during fire hazard, Proper housekeeping in order to prevent fire hazards, Correct use of a fire extinguisher. Emergencies, rescue and first-aid procedures, Appropriate first aid to victims where required eg. in case of bleeding, burns, choking, electric shock, poisoning etc, Organize loss minimization or rescue activity during an accident in real or simulated environments. Emergency procedures: raising alarm, safe/efficient, evacuation, correct means of escape, correct assembly point, roll call and correct return to work. Accident/incident report. (Incident Report includes details of: name, date/time of incident, date/time of report, location, environment conditions, persons involved, sequence of events, injuries sustained, damage sustained, actions taken, witnesses, supervisor/manager notified). Correct method to move injured people and others during an emergency.

08Hrs

Module 6

Working Effectively with others at work, Accurately receive

information and pass on information to authorized persons who require it and within agreed timescale and confirm its receipt, Display appropriate communication etiquette while working (Communication etiquette: do not use abusive language; use appropriate titles and terms of respect; do not eat or chew while talking (vice versa)etc.), Demonstrate responsible and disciplined behaviors at the workplace. (Disciplined behaviors: e.g. punctuality; completing tasks as per given time and standards; not gossiping and idling time; eliminating waste, honesty, etc), Escalate grievances and problems to appropriate authority as per procedure to resolve them and avoid conflict
06Hrs

Module 7

Metal casting and forming processes: Sand Casting : Sand Mould – Type of patterns - Pattern Materials – Pattern allowances –Moulding sand Properties and testing – Cores –Types and applications – Moulding machines– Types and applications; Melting furnaces : Blast and Cupola Furnaces; Principle of special casting processes : Shell– Ceramic mould – Pressure die casting - Centrifugal Casting - CO2 process – Stir casting; Defects in Sand casting. Metal forming processes: Hot working and cold working of metals – Forging processes – Open, impression and closed die forging – forging operations. Rolling of metals– Types of Rolling – Flat strip rolling – shape rolling operations – Defects in rolled parts. Principle of rod and wire drawing .
04Hrs

Text Books:

1. Kalpak Jain, Manufacturing Engineering & Technology, Addison Wesley,1997
2. Poul De Garmo, J.T.Black, R.A.Kosher, Materials and Processes in Manufacturing , Prentice Hall of India, 1997.
3. Production Technology - Jain , Agarwal

Reference Book:

1. R.K. Jain, Production Technology, Khanna Publishers, 2001
2. R.K. Gupta, Production Technology, Sathya Prakashan, 2010

Course code: 17VT204 Total Hours : 30 hrs	BASIC ELECTRICAL & ELECTRONICS	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to make the students understand : 1. The importance of basic principles of electrical electronics for industrial application. 2. Electrical and Electronic measuring
Course outcomes	Students after the completion of this course will be able to : 1. Learn basic concepts and working of electrical devices.

Module 1

Electrical Safety -Electrical safety, Important of Earthing, Electric shock, First aid for electric shock, Precautions against shock, Cause of accidents and their preventive measures, Electronic Materials and Components- Conductors, Semiconductors and Insulators, Properties and Applications, Resistors, Capacitors, Inductors- Specifications and Applications, Diodes, Transistors and ICs- Specifications and applications. 06 Hrs

Module 2

Cables and Wires- Types, Specifications and Applications, Care to be taken while connecting cables / wire to terminals of motors, switches, Color coding of cables and wires- Phase, Neutral, Earth. Measuring instruments- Ammeter,

Voltmeter, CRO, Multimeter. **04 Hrs**

Module 3

DC & AC Circuits- Definitions- Electric current, Voltage and Resistance, Ohm's Law and Kirchoff's Laws, Resistance in series, parallel, Simple problems. Fundamental of AC Voltage and current, Peak, Average, RMS value, of sine wave, Frequency, Time period, Amplitude, Power, Power Factor, Single Phase / Three Phase connections, Delta, connections, Relationship between phase and line voltages, Current in star and Delta connections. Electrical Protective Devices- Different types of switches, Fuses and their applications, MCB – Specification, Application, ELCB / RCCB- specification, Applications. **06 Hrs**

Module 4

Rectifiers and Power supply- Rectifiers, Types and applications, Regulated Power supply.

DISPLAY DEVICES- Application of LED, LCD. **07 Hrs**

Module 5

Sensors- Types, Applications.AC Machines- Transformer, Types of transformers (current and Voltage), Principle of operation of transformers, Applications of transformer,Single phase induction motor- Working principle, Applications, Three Phase induction motor, Working principle, Control Elements, Applications. DC Machines- DC Generator & DC Motor, Construction, Principle of operation, Types and Applications.
07 Hrs

Text Books

1. Electrical Technology - B.L Theraja
2. Electrical Engineering Theory - K Mehta
3. Basic Electrical and Electronics - B L Theraja

Reference Books

1. Electrical Technology - H Cotton
2. Principles of Electrical & Electronics - V .K Metha

Course Code: 17VT205	MATERIAL TECHNOLOGY-I	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to make the students understand : 1. Mechanical behavior of engineering materials and their applications 2. Atomic and molecular structures of engineering materials 3. Mechanical properties of Ferrous & Non-				
Course outcomes	Students after the completion of this course will be able to : 1. Understand basic structure and terminology associated with engineering materials 2. Perform calculations to qualify materials properties and characteristics.				

Module 1

Scope of Material Technology- Historical perspective: Role of engineering material, Classification:- List and the different types of ferrous metals, pig iron, cast iron, wrought iron, steel. Metals and non-metals, Ferrous and non-ferrous, Properties of materials: Physical properties, Chemical properties, Magnetic properties, Mechanical properties. **05 Hrs**

Module 2

Ferrous metals- Introduction to manufacturing process, types, properties and application of the following- Pig iron, Wrought iron, Cast iron- grey, white, Steel-carbon steel, low, medium and high alloy steel.

Influence of following elements on the properties of steel- Carbon, Silicon, Phosphorous, Sulphur, Manganese. **05 Hrs**

Module 3

Alloy Steel- Introduction, Alloying elements and their effect on properties of steel, Chromium, Nickel, Vanadium, Tungsten, Molybdenum, Cobalt, Super alloys: Titanium based and Inconel. Materials used for manufacturing cutting tools, their properties and applications - Alloy steels, HSS, uncoated carbide, carbide, cermet, Ceramics, CBN(Cubic Boron Nitride) Poly Crystalline Diamond. **05 Hrs**

Module 4

Materials used in tooling- specification, composition, properties. Materials used in Jigs and fixtures, Press tools, Moulds, Die casting dies, Forging dies. Non Ferrous metals- Properties and application of: Copper and its alloys, Aluminum and its alloys, Zinc, Tin, Magnesium. **05 Hrs**

Module 5

Testing of Material: Introduction, Destructive and non-destructive tests, Destructive tests, Tensile test, Compressive test, Impact test, Nondestructive test- Visual, liquid penetration, magnetic particle, ultrasonic, radiographic Hardness testing- Rockwell, Brenell, Vickers. **05 Hrs**

Module 6 Non-metallic materials

Polymers – types of polymer, commodity and engineering polymers – Properties and applications of various thermosetting and thermoplastic polymers (PP, PS, PVC, PMMA, PET,PC, PA, ABS, PI, PAI, PPO, PPS, PEEK, PTFE, Polymers – Urea and Phenol formaldehydes)- Engineering Ceramics – Properties and applications of Al2O3, SiC, Si3N4, PSZ and SIALON –Composites-Classifications- Metal Matrix and FRP - Applications of Composites. 05Hrs

Text books

1.William D. Callister, Jr., "Materials Science and Engineering an Introduction", 2nd Edition, John Wiley & Sons, Inc., 2007.

2.V. Raghavan, "Materials Science and Engineering", Prentice – Hall of India Pvt. Ltd., 2007

Reference books

1.J.M. Shackelford, Introduction to Materials Science for Engineers, 5th Edition, Prentice-Hall, Inc. 2000.

2.Suryanarayana, A. V. K., "Testing of Metallic Materials", Prentice Hall India, New Delhi, 1979.

3.W. Bolton, "Engineering materials technology", 3rd Edition, Butterworth & Heinemann, 2001.

4.William F. Smith, "Structure and Properties of Engineering Alloys", Mc-Graw-Hill Inc., U.S.A, 2nd edition, 1993.

5.Kingery, W. D., Bowen H. K. and Uhlmann, D. R., "Introduction to Ceramics", 2nd Edition, John Wiley & Sons, New York, 1976.

Course code: 17VT206 Total hours: 30	QUALITY MANAGEMENT -II	L	T	P	C
			--	--	2
Course objectives	The objective of this course is to make the students : 1 Understand terminology in Metrology and usage of measurements in industry 2 Familiarize with different measuring instruments and their working principles 3 Familiarize about marking and marking tools				
Course outcomes	Students after the completion of this course will be able to : 1. Understand the various terms and parameters used in measurements				

Module 1

Limits, Fits and Engineering tolerances: Limit systems – advantages, Interchangeability, Elements of limit system: nominal size - basic size actual size -allowance - limits - upper - lower - tolerance - unilateral – bilateral ,Fit: hole and shaft: Types of Fits: clearance - interference – transition, I.S.919 - 25 Fundamental deviation - 8 Tolerance grades - symbols - numeral - letter - terminology - zero line - deviation - upper –lower, Symbols for tolerance deviation and fit - hole basis and shaft basis system - practice problems - guidelines for selection of fits. Selective assembly **08Hrs**

Module 2

Taper and angular measurement & measuring tools: Definition of taper - taper elements, Specification of taper – conicity, Standard tapers - morse – metric, Measurement of angle - universal bevel protractor - parts of bevel protractor - construction of vernier scale - least count.method of checking – problems, Sine plate - construction – use Sine centre – use ,Spirit level - principle - construction , Angle gauges - use - number of gauge blocks in standard set addition and subtraction of angles – problems

08Hrs

Module 3

Comparators: What is a comparator - classification based on method of magnification? Advantages and dis-advantages, Mechanical comparator – Dial type & universal- working.

04Hrs

Module 4:

Measuring machines: Toolmaker's Microscope – parts – protractor eye piece – radius measuring head – thread template unit – projection attachment – applications. Profile Projector. Co-ordinate Measuring Machine – XYZ co-ordinates. **05Hrs**

Module 5. Measurement of Power and Flow

Measurement of power, flow and temperature Force, torque, power - mechanical , Pneumatic, Hydraulic and Electrical type. Flow measurement: Venturimeter, Orifice meter, rotameter, pitot tube – Temperature: bimetallic strip, thermocouples, electrical resistance thermometer – Reliability and Calibration – Readability and Reliability. Vibrations measurement, frequency, displacement, velocity & acceleration, Modes of heat transfer, Fourier Law of heat conduction, thermal conductivity, temperature distribution in composite wall

05Hrs

Text Books:

1. Beckwith Marangoni and Lienhard, "Mechanical Measurements", Pearson Education, 6th Edition, 2006.
2. A. K Sawhney, "A course in Mechanical Measurements and Instrumentation", Dhanpat Rai Publications.

Reference books

1. Alan S. Morris, "The Essence of Measurement", Prentice Hall of India, 1997
2. Beckwith T.G, and N. Lewis Buck, "Mechanical Measurements", Addison Wesley, 1991
3. Ernest O. Doebelin, "Measurement Systems Applications and Design",5th Ed., McGraw Hill Book Co.
4. N. V. Raghavendra and Krishnamurthy, "Engineering Metrology and Measurement", Oxford University Press.

Course Code: 17VT207 **Total Hours : 75 hrs**	**ENGINEERING DRAWING AND CAD-II**	**L**	**T**	**P**	**C**
		-	**-**		**5**

Course objective	The objective of this course is to make students : 1. Understand the principles and requirements of machine & production drawings 2. Understand and interpret drawings of machine components so as to prepare assembly drawings using standard CAD packages 3. Develop the technical skills necessary to
Course outcome	Students after the completion of this course will be able to : 1. Create drawings of Bolted, Riveted & Welded joints and Couplings 2. 3D (Solid) models of engineering components, sub-assemblies &

Module 1: Dimensions and Tolerances

Classifications of dimensions- functional, nonfunctional, auxiliary, and features, IS specified tolerance. - Indian standard/ISO system of limits and fits (IS919, ISO 286), Fits.- clearance fit , transition and interference fit. General tolerance. – IS 2102{part1 and part2}. Exercise for general tolerance. **9Hrs**

Module 2: Sectioning and Surface structure

Introduction about sectioning, Classification of section views- Full section, half section, local section, revolved section, removed section, offset section, auxiliary section, and aligned section, General rules of sectioning. - hatching of single object, adjacent object, thin material, large area, rib & web section, Conventional representation for hatching, Cutting plane line, Exercise.Introduction, - Types of surface texture, nomenclature of surface texture, Indication of surface roughness, Symbols of specifying the direction of lay, Example. **12Hrs**

Module 3: Permanent Fastenings

Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets) Common types of joints, terminology, proportions and representation; Welds: Types of welds and welded joints, edge preparation, specifications, and representation of welds on drawings **10Hrs**

Module 4: Screwed Fasteners

Introduction, Screw thread nomenclature. - Major dia, minor dia, pitch, lead, flank, crest, root, thread angle etc.… Forms of thread- metric thread, V thread, BSW thread, Buttress thread,

Square thread, ACME thread, and worm thread, Single and multi-start thread, Thread specification, Conventional representation of threads, Different types of bolt and threads. – Bolt, nut, set screws, locking screws, lock nuts, Socket head cap screw and CSK screw and assembly. **16 Hrs**

Module 5: Geometrical Tolerance

Introduction about geometrical tolerance, Tolerance frame and features, Indication of features of control, Datum. - Primary, secondary and tertiary datum, Exercise **14 Hrs**

Module 6: Assembly and detailed drawing

Introduction about assembly and part drawing, Assembly drawing, Detailed drawing, Exercise. – tap wrench, U clamp with V block, assembly fit, C-clamp, Tool makers clamp &,Guide plate tool. **14 Hrs**

Text books

1.N.D. Bhat & V.M. Panchal 'Machine Drawing'
2.French, T. E., Vierch, C. J., and Foster, R. J., Engineering Drawing and Graphic Technology,14th Ed., McGraw-Hill, 1993

Reference books

1. S. Trymbaka Murthy, 'A Text Book of Computer Aided Machine Drawing', CBS Publishers, New Delhi, 2007
2. K.R. Gopala Krishna 'Machine Drawing', Subhash Publication.
3. Narayana K.L., Kannaiah, P., and Venkata Reddy K, Machine Drawing, 3rd Ed., New Age International Publishers, 2006.
4. Johan K. C., Text Book of Machine Drawing, PHI Learning Pvt., 2009

Course Code: 17VT208	WORK SHOP - II	L	T	P	C
		-	-		8
Course objective	The objective of this course is to make the student aware of : 1. The basic fundamentals and mechanics of metal cutting, tool geometry, tool life and tool wear 2. Knowledge on tool materials, tool life, tool wear, effect of lubrications and coolant used in machining operation. 3. The basic knowledge of various machine tools, classification, specification, operations of each				
Course outcome	Students after the completion of this course will be able to : 1. Understand the mechanics of metal cutting operations, various tool materials, parameters affecting machining operations like feed, speed, coolant, tool life, tool wear, and temperature **2.** Apply knowledge of machining processes to				

LIST OF EXPERIMENTS

1. Introduction of General Purpose Machines.
2. Study of Single Point Cutting Tool and Multi Point Cutting Tool.
3. To Study of Mechanism in Lathe and Perform Various Operations on a Lathe Machine.
4. To Study Construction, Working and Performing Operations on a Drilling Machine
5. To Study Construction and Working of Milling Machine.
6. To Study Construction, Working and Perform Grinding Operation on a Grinding Machine.
7. Introduction of Computer Numerical Control Machines and Demonstration of Few Work Pieces Jobs.
8. Use of foundry tools and other equipment, preparation of moulds using two moulding boxes with or without patterns. (Split pattern, Match plate pattern and Core boxes).
9. Preparation of one casting (Aluminum or cast iron-demonstration only)
10. Forging Exercises

Self-study exercise.

Text Books:
DSU Manufacturing process lab manual

Course code: 17VT209 Total Hours: 30hrs	ELECTRICAL & ELECTRONICS LAB	L	T	P	C
		-	-		2
Course Objectives	The objective of this course is to make students : 1. Expose to overall exposure to basic Electrical & Electronics Components and Devices. 2. Analyze Ohm's, Kirchoff laws 3. Understand the different motor's operation and principle				
Course outcomes	Students shall be able to 1. Demonstrate the basic skill to operate electrical and electronic equipment's and devices.				

LIST OF EXPERIMENTS

1. Forming mesh and soldering exercises using 22SWG tin coated copper wire
3. Forming resistors and soldering them on to a groove board and PCB
4. Tinning multi strand copper wire, forming, assembling and soldering electronic components on PCB, and desoldering Practice
5. Extension of ammeter range
6. Conversion of DC ammeter to DC voltmeter
7. Charging and discharging curves of a capacitor
8. Introduction to lab safety,procedure,5S,rules and regulations
9. Familiarization of Tool kit, and basics of bread board connections, CRO, MULTIMETER, power supply
10. Ohm's law
11. Kirchoff s current and voltage law
12. VI characteristics of diode
13. Rectifier –Half wave and full wave rectifier.
14. Clipper and clamper circuits.
15. A C and D C Motors

Self-study exercise.

Text Books

4. Electrical Technology - B.L Theraja

5. Electrical Engineering Theory - K Mehta
6. Basic Electrical and Electronics - B L Theraja

Reference Books

3. Electrical Technology - H Cotton
4. Principles of Electrical & Electronics - V .K Metha

Course code17VT210 Total Hours: 45hrs	**QUALITY MANAGEMENT LAB-II**	**L**	**T**	**P**	**C**
			-		3
Course Objectives	Students after the completion of this course will be able to: 1. Introduce the students to the need, standards and principles of measurement. 2. Introduce the students to the principles of various				
Course outcomes	Students after the completion of this course will be able to: 1. The purpose of this course is to provide the student with a basic understanding of the theory and practice of measurement and instrumentation. 2. Recognize the basic elements of common measurement systems. 3. Be able to estimate the accuracy of a measurement				

1. To study the vibration measurement, frequency, displacement, velocity & acceleration.

2. Calculation of the Rate of Flow Using Rotameter-To calibrate rotameter at different flow rates with actual discharge
3. Determination of flow rate through Orifice Meter –and also to determine the co-efficient of discharge for orifice meter at different flow rates.
4. Determination of flow rate through of the Given Venturimeter and also determine the coefficient of discharge for venturimeter at different flow rates.
5. Determination of thermal conductivity of metal rod
6. Determination of thermal conductivity of composite wall

Self-study exercise.

Course code: 17VT301 Total Hours: 30 hrs	PRODUCTION TECHNOLOGY - III	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students : 1. Awareness of advanced milling 2. Awareness of advanced grinding 3. Familiarization of broaching 4. Highlights of jig grinding and jig boring 5. Awareness of super-finishing process 6. Familiarization of electric discharge				
Course Outcomes	Students after the completion of this course will be able to : 1. Explain the various machining processes such as turning, drilling, milling and grinding. 2. Analyze the various manufacturing processes such as casting, hot working and cold working.				

Module 1

Milling-Cutting speed-Feed- depth of cut- machining time calculation - machining time for Face milling and Peripheral milling. Indexing- Types of indexing head- direct indexing heads, principles of direct indexing, direct indexing mechanisms-simple indexing head, plain or simple indexing-Angular indexing. **Broaching-**The process of broaching: Different types of broaching machines and its working principle. Different types of broaching tools: Elements of broaching tool. **05Hrs**

Module 2

Grinding: Taper grinding - gear tooth grinding - wet and dry grinding. Grinding wheel: Specification of grinding wheels - abrasives - bond grain - grade - structure – different types of grinding wheels according to shape-standard marking system of grinding wheels. Dressing of wheel. Machining time calculation: In surface grinding – face grinding - circumferential grinding - cylindrical grinding. Tool and cutter grinder. calculation for regrinding of single

point tools, milling cutters, reamer, drills, broaches. **05Hrs**

Module 3

Jig boring and Jig grinding-Jig boring: Different types of machines - parts of machine - function - different tools for jig boring Jig grinding: Different types of jig grinding machines - types of operations on jig grinding machine. **Super finishing process** -Honing: The purpose – process of honing – the honing machine – advantage and dis-advantage of honing. Lapping: The process - purpose - machine - lapping tool and medium - advantages and dis-advantages of lapping. **Electric discharge machining**: Principle of operation process of sparking – sparking machine – main parts of the machine – thread cutting on sparking machine. Electrode: The material for electrode -type of electrodes - roughing and finishing – allowances provided while designing. **06Hrs**

Module 4

Manufacturing processes-Casting: Process of casting - Advantages and disadvantages of casting- Explain types: Sand casting - Investment casting - Centrifugal casting - Die casting. Mechanical working of metals: Hot working - cold working - merits and demerits-Types of hot working: Rolling - Forging - Piercing-Drawing- Spinning- Extrusion- Types of cold work: Cold rolling - Cold drawing - Bending - Squeezing - Peening - Spinning. Powder metallurgy: Process - Manufacturing of powder: Character of powder - Safety in handling - Size of powder - Blending of powder - Compacting – Pre-sintering- sintering - secondary operation. Product produced- advantages - disadvantages – limitations.

07Hrs

Module 5

Processing of ceramics and glass-production of metal powders: Compaction – Sintering and Finishing – Design, Considerations for powder metallurgy and Process capability – Shaping of ceramics –Forming and shaping of glass – Design considerations for ceramics and glass – Processing of superconductors. **Thermal Spray and Laser Surface Modification**-Thermal spraying, techniques, advanced spraying techniques - plasma surfacing, detonation gun and high velocity oxy-fuel processes, laser surface alloying, laser cladding, specific industrial applications, tests for assessment of wear and corrosion. **Vapor Deposition Techniques**-Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities, chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD.

07Hrs

Text Books:

1. Sudarshan T S, Surface modification technologies - An Engineers Guide, Marcel Dekker, Newyork, 1989
2. Varghese C.D, Electroplating and other Surface Treatments - A Practical Guide", TMH, 1993.
3. Workshop Technology – Chapman

Reference Books:

1. Modern W/s Technology - Wright Baker
2. All about machine tools - H.Gerling
3. Machine Technology- P.M Johnston

4. Production Technology - Jain, Agarwal

Course code: 17VT302 Total Hours: 30	MATERIAL TECHNOLOGY & HEAT TREATMENT	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students : 1. Highlight the atomic bonds, in the structure of metal 2. Awareness of the crystalline structure, solid solutions, solid phase and phase diagram. 3. General awareness of solidification of metals 4. Awareness of general HT terms, process and				
Course outcomes	Students after the completion of this course will be able to : 1. Understand the Structure and Properties of various Materials and their importance in Modern Technology. 2. Identify the structure of materials - Unit cell, space lattice, BCC, FCC, & HCP structure, Atomic Packing factor.				

Mdule 1

Atomic bonds - Explain the atomic bond, Classification of atomic bond: primary bond - secondary bond Primary Bond: Ionic bond – covalent bond - metallic bond, compare the different types of bond: Ionic and metallic - covalent and metallic. **Crystalline structure -** Introduction - Types of solids: crystalline solid – non crystalline solid -explanation of crystal and crystal structure, Space lattice - Explain unit cell and space lattice -Classify the space lattice: body centered cubic lattice - face centered cubic lattice-closed packed hexagonal lattice, Crystal imperfection-Explain crystal imperfection effect of crystal imperfection on the mechanical properties of metals- how defects happen- explain 4 types of point defects (Vacancies, interstitial , Frenkle , Substitution) , explain line defects , explain surface defects (grain and twin boundary) **06 Hrs**

Module 2

Solid solution - Solid solutions - classify – explain, Solid phases and its types – Explanation on what is solid solution, types of solid solution (interstitial solid solution and substitutional solid solution), Explanation on Basic phase diagram, explain alloy. **Solidification of metals -** Explain the solidification process -explain the structural changes in steel - Explain iron carbon diagram (more specific up to 2 % carbon&1200 degree centigrade). **Metallurgical microscope -** Metallurgical microscope – working principle, uses. Parts and function. Care to be taken while in use. Procedure of preparing the specimen for microscopic testing.

06 Hrs

Module 3

Heat Treatment - Definition, scope and safety, Principle of Heat Treatment, interpretation of

iron carbon diagram, TTT diagram, Microscopic Structure and Structural Transformation, Process and process variables – sequence of operation-heating, soaking and cooling, heating and cooling rate, Heat Treatment temperature and holding time, Types of Heat Treatment – stress relieving, annealing, normalizing Hardening and Tempering, Case hardening and surface hardening and special Heat Treatment process, Carburising – Pack carburising, vaccum carburising, nitriding, gas nitriding and plasma nitriding, Localised case hardening-induction hardening and flame hardening, Special Heat Treatment - Martempering and Austempering, Subzero treatment. **Heat Treating Equipment -** Heating media – Furnace – Fuel fired furnace, electrically heated furnace, bath furnace and vaccum furnace, Fuel used in furnace heating –Solid, liquid and gaseous fuel, Advantages and disadvantages of bath furnace and hearth furnace, Quenching media – water, oil, gas, aqueous solution and salt bath, Tempering measurement and control – thermometer, pyrometer, thermocouple, & segar cone.

06 Hrs

Module 4

Post Heat Treatment - Remove of scale – acid pickling and grit blasting – alkaline detergent cleaning and degreasing – straightening, Hydrogen de-embrittlement treatment. **Heat Treatment of different materials -** Heat Treatment of tools steels – Hot worked tool steel & cold worked tool steels, high speed steel, stainless steels and spring steels, Heat Treatment of non-ferrous material – aluminium and its alloys and copper and its alloys. **Possible defects and remedies in Heat Treatment -** Low hardness and strength after hardening, soft spots, oxidation and carburisation, overheating and burning, formation of cracks, - development of cracks- distortion and wrapping, Discus causes and remedies.

06 Hrs

Module 5

Surface Treatment - Mechanical cleaning and finishing – vibratory finishing, belt standing, wire brushing, buffing and electro polishing, Chemical cleaning – vapor degreasing, solvent cleaning, alkaline cleaning. Ultrasonic cleaning and acid pickling, Burr removal – design to facilitate or eliminate burr removal, Coatings – painting, dipping spraying, powder coating – blackening – electroplating, Vaporised metal coating – vaccum metalizing, (sputtering) physical and chemical vapor deposition. **Planning for Heat Treatment and case study -** Preparation of the work piece – setting of furnace Case study and revision. **Modern Metallic and Non Metallic Materials -** Modern Metallic materials: Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys - Metallic glass - Quasi crystal and nano crystalline materials, bio materials. Non Metallic Materials: Plastics, rubber, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, processing and applications

06 Hrs

Text Books

1. Thomas H. Courtney, Mechanical Behavior of Materials, McGraw-Hill, 2000.
2. Flinn, R.A. and Trojan, P.K., Engineering Materials and their Applications, (4th Edition),

Jaico Publishing, 1999.

3. Gabor L. Hornyak, H.F. Tibbals, Joydeep Dutta and John J. Moore, Introduction to Nano Science and Nanotechnology, CRC Press, Boca Raton, 2009.

Course code :17VT303 Total Hours: 30	STRENGTH OF MATERIALS-I	L	T	P	C
			-	-	2
Course objectives	The objective of this course is to enable students : 1. To understand the basic concepts and terms on materials. 2. To understand the stresses developed in bars, compounds bars, shafts, cylinders and spheres. 3. Understand the relationship of direct stresses 4. Understand the effect of direct shear stresses				
Course outcomes	Students after the completion of this course will be able to : 1. Apply concepts of strength of materials to obtain solutions to real time Engineering problems. 2. Students will analyze the terms involved and apply knowledge for deformation. 3. Understanding the mechanical terms and				

Reference Books:

1. Material Science & Process - Hajara Choudhari
2. Material and Metallurgy - V.K Manchanda
3. Material Science - R.S Khurmi
4. Material Science - O P Khanna
5. Materials for Engineering (Part 1&2) - P. S Houghton
6. Materials for Engineering (Vol 1&2) - P. S Houghton
7. Materials and processing in manufacturing – E. Paul DeGarmo,J.T. Black and Ronald A. Kohser
8. Heat Treatment Principle and techniques - T.V. Rajan, C.P. Sharma
9. Material Science and Process - G.B.S. Narang
10. Heat Treatment Handbook - Prabhu Dev
11. Heat Treatment Fundamentals -S Rolland Churchill

Module 1

Simple stresses and strain - Introduction - importance of studying strength of material in Tool making, Load - definition and explanation about tensile load and compressive load - effect of load in elastic material, Stress and strain, tensile stress, compressive stress and strain- plain rod in a state of compression – elasticity elastic limit and permanent set, Hooke's Law : Modules of elasticity – problems, Stress and strain produced in a bar by its own weight – problems, Elongation of bar of varying cross section - stresses in composite bars - problems, Elastic constants-Effect of axial load on lateral dimensions lateral strain-linear strain - Poisson's Ratio problems, Bulk modulus-Relation between Bulk modulus and Youngs' modulus, problems, Tensile test: - tensile test for mild steel - stress - strain curve for M.S. - stress strain curve for different materials, Compression test. **07 Hrs**

Module 2

Direct, shear stress - Shear force - shear stress - comparison of shear and normal stresses - deformation due to shear stress - shear strain - modules of rigidity - modules of rigidity of different materials - workshop related problems.

03 Hrs

Module 3

Thermal effect on stress and strain - Nature of stress developed by preventing expansion due to heat in machine members - equation for the stress due to change of temperature when the expansion is completely prevented - equation for the stress due to change of temperature when the expansion is partially prevented - practical examples of thermal stresses in Tool Engineering. **06 Hrs**

Module 4

Struts and Columns - Definition: Strut – Column, Effect of axial load on column-failure of a column or strut formula related with the compressive load - bucking load, Euler‘s Column theorem: Expression for buckling load assumption in Euler's column theory, Types of end conditions of columns - both the ends hinged -both ends fixed - one end fixed and other end hinged - one fixed and other end free – problems related with the end conditions - finding punch length in press tools.

07 Hrs

Module 5

Thin Cylinders, Spheres and Thick Cylinders - Stresses in thin cylindrical shell due to internal pressure circumferential and longitudinal stresses and deformation in thin and thick cylinders, spherical shells subjected to internal pressure, Deformation in spherical shells, Lame's theorem.

07 Hrs

Text books

1. S. S. Bhavikatti, "Strength of Materials", Vikas publications House-Pvt. Ltd., 2nd Edition, 2006
2. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, 2007.

Reference books:

1. Strength of Material-Vol.I - Timoshenko
2. Strength of Material-Vol.II - Timoshenko
3. Strength of Material - RS Khurmi
4. Strength of Material - Ramamrutham
5. Strength of Material - Surendra Singh
6. Strength of Material - William A Nash
7. Strength of Material - L.B.Prasad
8. Machine Design -Pandya & Shah

Course code: 17VT304 Total Hours : 30 hrs	PRESS TOOL TECHNOLOGY-I	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to make the students : 1. Awareness of different types of sheet metal processing using press tools 2. Ability to determine cutting force & cutting clearance. 3. Awareness of basic design of press tools. 4. Familiarization of elements of guide plate tool. 5. Awareness of basic design of progressive tool. 6. Ability to design a strip lay out. 7. Familiarization of different types of punches & Die blocks.				
Course outcomes	Upon successful completion of this course, the trainee will be able to: 1. Explain the necessity of press tool for Manufacturing of Stage, Progressive, Bending and Compound tools. 2. Analyze the design constraints in the given problem. 3. Apply the design rule for designing and manufacturing of press tools. 4. Design and Drafting of press tools for				

Module 1
Introduction to press tools- Different Press Tool operations, Awareness on different types of press tools. **Stock material**- Relationship of piece part and stock strip, Material- Stock materials used in press work - mechanical properties of different stock material - choosing material for the required press operation - preparation of stock material-Standards – types behaviour, Differentiate stock strip and unit stock. **Theory of Shearing**- Shearing theory description in press tool, Critical stage of shearing.

04 Hrs

Module 2 Cutting Force & Cutting clearance- Calculation of cutting force for press tool operation, Selection of suitable press, Methods for reducing cutting force, Cutting clearance: Explanation - Importance of cutting clearance, Typical appearance characteristics: Identify less or more clearance by visual inspection of the component, Relationship between piece part size to punch and die size, Determine punch and die dimension. Basic design of Guide Plate tool- Working principle of guide plate tool - when to adopt guide plate tool - Importance of each part of the tool -design of guide plate tool -Selecting material-Planning production.

05 Hrs

Module 3

Elements of guide plate tool- Punch – dies – Punch – Base plate – Guide block –Dowels – Fasteners – Clearance – Angular Clearance– Shank. **Land and Angular clearance**- Importance of angular clearance - methods used in providing angular clearance to be provided depending on stock material. **Basic design of Progressive tool**- Working principle of progressive action – Progressive Guide Plate tool, Compare between single station Guide plate tool and Progressive Guide Plate tool. **Strip lay out**- Importance of strip lay out, Different types of strip lay out: - narrow run - wide run- single row - two pass - double row lay out – gang dies - angular lay out - shape of the blank -production requirement grain direction - burr side -stock material, Strip lay out for blanking tool- Cut off-parting –notching - trimming-progressive tools, Strip lay out for blanking tool- Cut off-parting –notching - trimming-progressive tools.

05 Hrs

Module 4

Die blocks & Punches- Die blocks, Types of dies – Solid dies – Split dies or sectional die block, Requirement of die blocks-different methods of construction of die blocks-selection of die blocks, Selection- Material for die blocks- Heat treatment, Punches, cutting punches- non cutting punches – hybrid punches, Types of punches, Selection of punches depending on the work- material of punch. **Strippers**- Function of a stripper, Types of stripper, Constructional details of stripper - Spring strippers -Clamping spring stripper - Non clamping spring stripper - Piloting through spring stripper -Compensating washer - Spring around stripper bolts-Stripper bolt suspension, Stripping force- Stripping force for blanking and piercing. **Stoppers-** Basic stop principles - Stop position - Stop categories -Primary - secondary – final, Construction of different types of stoppers- plain pin stop - headed pin stop - disappearing pin stop – finger stop - operation - pusher stop - trigger stop.

08 Hrs

Module 5

Pilots- Purpose of pilots Differentiating between indirect piloting and direct piloting -Pilot size - Pilot length -Pilot opening in die - Pilot opening in die shoe, Types of pilots - Function of different types of pilots -retractable pilots - removable type pilots - pilot in. **Side cutters-** Function of side cutters, Advantages of side cutter. **Ejectors and shedders**- Ejector – Function of ejector, Shedder - Function of shedder - Types of shedders – Positive shedder -Compression shedder- Shedding pins, knock outs- Function-Distinguishing between direct knockout and indirect knock out. **Fasteners and dowels-** Dowels: Function-Types of Dowels used in tooling - precaution while dowelling, Fasteners: Screws - Function - Types of screws like – socket head screws - counter sunk screw head screw - cheese head screw -set screw- Non threaded. Fasteners-Rivets-cotter pins. **Shank-** Different types of shanks employed in a press tool, Location of shank –Importance for locating shank in correct position – Shank point location (Arithmetical method)-Shank point location (graphical method).

08 Hrs

Text Books

1. Tool Design – Donaldson
2. Die Design Fundamentals - Paquin

Reference Books

1. Basic Die Making - Ostergarrd
2. American Society of Metals - Hand Book 8th edition.Volume 4 forming.
3. Advanced Die Making - Ostergarrd
4. Fine blanking Seminar Notes - N T T F
5. Fundamentals of Tool Design - A.S.T.M.E
6. Tool Engineers hand book
7. Die Design Hand book
8. PSG Hand book
9. CMTI Hand book

Course code: 17VT305 Total Hours: 30 hrs	JIGS & FIXTURES	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to make the students understand : 1. Awareness of the difference between jig and fixture. 2. Highlight the types of jig and fixture. 3. General awareness of mounting jig and fixture on a machine tool. 4. Awareness of elements of jig and fixture. 5. Awareness of design of jigs, fixture. 6. General awareness of cutting forces acting on jig				
Course Outcomes	After successful completion of the course, the students should be able to : 1. Categorize and justify the requirements of Jigs and Fixtures for Manufacturing, Testing and Assembly CO2 2. Describe and implement various indexing mechanics in manufacturing. 3. Analyze problems related to Jigs and				

Module 1
Introduction to Jigs and fixture- Introduction – jig, fixture, Function of jig, fixture, Difference between jig and fixture, Economic use of jig and fixture. Planes of movement- Principle of location, Freedom of movement of an object.

06 Hrs

Module 2
Possible movements of work piece- Arresting the freedom of movement, Clamps, stoppers, in a jig fixture. **Location of work piece-** Purpose of location, Fool proofing of work, Body, feet of jig, fixture, chip control. **06 Hrs**

Module 3
Different types of jigs- Template jig, Table jig, Plate jig, Angle plate jig, Modified angle plate jig, Sandwich jig, Box jig, Channel jig, Leaf jig, Indexing jig. **06 Hrs**

Module 4

Different types of fixture- Plate fixture, Angle plate fixture, and Modified angle plate fixture, vice jaw fixture, Fixture and machine relation, Jig and machine relation. 06 Hrs

Module 5
Elements of jig and fixture- Clamps, Stoppers, Supports, Plugs, Types of drill bushes. **Jig, fixture and cutting tool relation-** Types of tools, Cutting tool setting, Chip direction, Chip removal. **Design steps to be followed for Jigs and Fixtures-** Design principles - care – procedure. **Failure of jig and fixture-** Failure of elements, failure of clamping-Discuss the above with case study. **Effect of heat treatment on jig, fixture elements-** Cutter setting block, body, feet, Drill bushes. **06 Hrs**

Text Books:
1. Jigs and Fixtures - Hiran E Grant
2. Jigs and Fixtures Design - Franklin D Jones

Course code :17VT306	QUALITY MANAGEMENT-III	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students : 1. To understand the basic concepts on measurements and their terms. 2. To provide knowledge on various measurement equipment sand components. 3. To learn the procedure adopted to measure the				
Course outcomes	Students after the completion of this course will be able to : 1. Students will have thorough knowledge on different measurement components				

Reference Books:

1. Jigs and Fixtures - Joshi
2. Jigs and Fixtures - Hiramegrant
3. Die Design Fundamentals - ASTME
4. P S G Hand

Module I

Hardness checking - Hardness – property, checking methods - Brinnel - indentor used - load – method, Rockwell principle - RA, RB and RC- indentor used lead for different scales, Vicker's hardness - indentor used – load, Shore scleroscope hardness test.

06 Hrs

Module II

Interferometry - Principles of Optical Interference Wave Length wave in phase – wave out of phase – formation of interference bands, Interferometry Applied to Flatness Testing – optical flat – material size – method of checking, Fringe Pattern Obtained On: flat surface – convex surface – concave surface – surface with high points – surface with low edges, Measurement of Slip Gauge Size – use of interferometer.

06 Hrs

Module III

Form and position features - Straightness – definition, Measurement of straightness, Flatness - definition - testing - surface plate – straight edge method -auto collimator method - use of optical flats, Parallelism - dial indicator - use - types - plunger type working - working principle - precautions -universal dial indicator-working working principle – precautions, Parallelism of 2 axes- parallelism of 2 planes parallelism of axis to a plane, Squareness - trysquare - indicator method –auto collimator method, Measurement of circularity - ovality -lobbing- use of dial indicator and V block – Talyrond, Concentricity - checking using dial indicator, Run out – checking.

06 Hrs

Module IV

Miscellaneous measurement - Checking the angle of a piece tapered at one end, To check the angle of a tapered hole, Gear Tooth Vernier – tooth thickness measurement – gear tooth caliper, Plug method for checking Pitch Diameter and Tooth test. **06 Hrs**

Module V

Surface texture measurement - Meaning of surface texture - difference between length measurement and surface texture measurement, Effective profile, Method of Measuring – inspection by comparisons - direct instrument measurement, Stylus probe instruments – essential parts, Profilometer, Tomlinson's surface meter, The Taylor Hobson Talysurf , The Sigma Micotest, The Ruler 'Mercin' Roughness Instrument, Talysurf (electronic surface indicator), Analysis of surface traces – Peek to valley height – Root Mean Square (RMS) Value – Centre line average method. **06 Hrs**

1. **Text Books** Beckwith Marangoni and Lienhard, "Mechanical Measurements", Pearson Education, 6th Edition, 2006.
2. A. K Sawhney, "A course in Mechanical Measurements and Instrumentation", Dhanpat Rai Publications.
3. Alan S. Morris, "The Essence of Measurement", Prentice Hall of India, 1997

Reference books:

1. Engineering Metrology - R.K Jain
2. Mechanical and Industrial measurements - R.K Jain
3. Dimensional Metrology - M.K Khare
4. Engineering Metrology - K.J Hume

Course code: 17VT307	WORKSHOP-III	L	T	P	C
			-		6
Course Objectives	The objective of this course is to enable students : 1. Understanding the concepts of different operations such as Bench work, milling and				
Course outcomes	Students after the completion of this course will be able to: 1. Work independently on different operation such as Bench work, milling, Turning, surfac				

LIST OF EXPERIMENTS

1. **Manufacturing of elements of Progressive Tool-** Top Plate, Bush, Punch holder, Stripper plate, Die plate.
2. **Manufacturing of elements of Progressive Tool -** Bottom plate, Spacer, Extension table, Finger stopper.
3. **Manufacturing of elements of Progressive Tool -** Shank, Blanking punch, Piercing punch, Pilot, Thrust Plate.
4. **Types of fits on Progressive Tool-** Offset Fit, Universal Fit.

Course code:17VT308	TOOL DESIGN DRAWING-I	L	T	P	C
			-		6
Course Objectives	1. The objective of this course is to enable students : 2. Understanding the basic principles and designing various types of fixtures. 3. Understanding the basic principles and designing various types of jigs. 4. Training in the ability to design different types of Guide Plate Tool. 5. Training in the ability to design different types of Blanking Tool with Die sets.				
Course outcomes	Students after the completion of this course will be able to: 1. Design and drafting various Jigs and Fixtures using appropriate software package.				

LIST OF EXPERIMENTS

1. **Design of Fixtures-** Design of Turning Fixture, Design of Milling Fixture and Design of Grinding Fixture.
2. **Design of Jigs-** Design of Plate Jig, Design of Box Jig, Design of Leaf jig and Design of Indexing Jig.
3. **Design of Guide plate tool-** Design a single stage guide plate tool and design of three stage guide plate tool.
4. **Blanking Tool with die set**
5. **Design of Progressive Tool-** Design of Progressive tool incorporating travelling stripper and Design of Progressive tool incorporating one or more of the following features.

- Traveling Stripper with split dies
- Cut –off punches with side cutter
- Parting – off punches

Fixed stop / Trigger stop / Auxiliary

Course code: 17VT309	MATERIALS LABORATORY	L	T	P	C
			-		4
Course Objectives	The objective of this course is to enable students : 1. Introduction to basic characterization techniques for materials, such as Hardness testing, Tensile testing, Shear testing, Compression, Bending, Fracture testing, Fatigue testing & Impact testing. 2. To study the different methods to enhance the				
Course outcomes	Students after the completion of this course will be able to : 1. Students will be able to demonstrate the knowledge, skills to conduct & analyzing the				

LIST OF EXPERIMENTS

1. **Tension Test**- To determine mechanical properties such as ultimate tensile strength, elastic modulus, proportionality limit, yield point, fracture stress, percentage elongation & reduction in area of metals & alloys and also study the behavior of material & characterize types of fracture under tensile load.

2. **Compression Test** -To conduct compression test on the given material and to determine properties such as compressive strength, modulus of elasticity, percentage constriction & percentage increase in area.

3. **Shear Test** - To determine ultimate shear stress of the given specimens in single and double shear.

4. **Bending Test** -To study the characteristics of materials under the gradually increasing flexural loading and to determine Modulus of rupture, Modulus of elasticity, Maximum shear stress.

5. **Impact Test** - (Charpy and Izod) - To find out the impact strength of the given notched specimens.

6. **Brinell hardness Test** -To determine the Brinell Hardness Number (BHN) of the given specimens.

7. **Vicker's Hardness Test** - To determine Vickers Hardness Number for a given specimen.

8. **Wear Test** - To determine the wear rate of different materials by using pin and disc apparatus.

9. **Torsion Test -** To determine the torsional shear stress

Course code: 17VT310	**QUALITY MANAGEMENT LAB-III**	**L**	**T**	**P**	**C**
			-		2
Course Objectives	The objective of this course is to enable students : 1. Experimentally determine Ra, Ry, Rz values for different surfaces and surfaces. 2. To Conduct GD and T experiments				
Course outcomes	Students after the completion of this course will be able to 1. Demonstrate the skills to carry out and analyze surface roughness values. 2. Demonstrate the skills to conduct GD and T				

List of Experiment:

1. To conduct surface roughness experiment on given specimen and to find out the roughness value.

2. Geometrical Dimensioning and Tolerance experiments (Fourteen Experiments)

Course code: 17VT401	MOULD TECHNOLOGY	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students : 1. Familiarization in the use of plastics in molding industry. 2. Familiarization of the working of injection moulding machine 3. Awareness of basic terminology of injection moulds and 4. Familiarization with mould material and their specification 5. Ability to determine the number of cavities and parting surface of an injection mold. 6. Highlight the importance of elements of feed system and ejection system in an injection mould. 7. Highlight the shrinkage on plastics and cavity/core calculations				
Course Outcomes	Students after the completion of this course will be able to : 1. Explain the importance of elements of feed system and ejection system in an injection mold.				

Module 1

Plastic in Moulding Industry- Introduction to polymerization, Thermoplastics and Thermoset plastics: Types - Property – Application, Fillers and Additives: Varieties - effect - Reinforcement of plastics, Identification of plastics: simple tests, Plastics for commercial products. **Injection Moulding Machine-** Different types of injection moulding machine - Plunger injection cylinders - Pre-plasticizer, two stage, plunger injection cylinder, two stage screw injection cylinder - Reciprocating screw injection cylinder - Purging - Injection moulding machine basic arrangement - The screw - The nozzle, Machine specifications -Injection capacity or short capacity - Plasticizing capacity-Injection rate or injection velocity - Injection pressure - Clamping force - Maximum Daylight.

05Hrs

Module 2

Basic Terminology- Elements of mould - Function - Fixed half - moving half - Impression - cavity - core - sprue bush - register ring - runner - gate - guide pillars and bushes - heel blocks - rest button - sprue breaker - ejector - ejector retainer - push back pins, Moulds and moulding methods, Mould material specification – selection based on type of material being molded – effect of wear occurring during moulding. **Number of cavities calculation-**Shot weight calculation - Plasticizing capacity calculation -Cycle time calculation - Clamping force calculation - Determination of number of cavities - Determination by shot capacity - by plasticizing capacity- by clamping capacity. **Parting surface-** choosing parting surface for different components – relief of parting – reason for relief for parting surface, Venting: Functions

of air vents – Position of air vents for different components.

06Hrs

Module 3

Feed system- Parts of feed system: Runner- Function-runner cross section shape - runner size - Gates - Function of gates - position of gates - balanced gates - types of gates - advantages of different types of gates - disadvantages of different types of gates, Runner diameter calculation – Gate calculation. **Ejection system-**Ejector grid: Types of ejector grid - Ejector plate assembly - Functioning -Ejector plate - retaining plate - guiding and supporting ejector plate assembly - ejector rod and ejector bush - Ejector plate assembly return system. Push back pin return system - spring return system - stop pins, Ejection methods - Pin ejection - D shaped ejector pins - sleeve ejection - blade ejection - valve ejection - air ejection - stripper bar ejection - stripper plate ejection - stripper ring ejection - Ejection from fixed half - Sprue pullers- Function and design of sprue puller. **Plastic Shrinkage-** Shrinkage - Explain shrinkage - Effect - Factors governing shrinkage - Values of shrinkage, Determine the core and cavity dimensions.

07 Hrs

Module 4

Temperature controlling for moulds- Need of temperature controlling for moulds – methods, Cooling method -Cooling integer type mould plates - Cooling insert bolster assembly -Cooling bolster - cooling cavity inserts - cooling core inserts - Water connections Adapters - position of water connection – plugs, Mould cooling calculation - Typical temperature - amount of water to be circulated per hour -solidifying time - length of cooling channel .examples - Estimation of cooling period. **Mould cycle**- Elements of mould cycle – Importance of mould cycle, Mould cycle diagram – Procedure – Preparation of mould cycle diagram during mold tryout.

05 Hrs

Module 5

Cavities- Selection of splits- Design of moulds with splits- External undercut components - Position of joint line, Splits - sliding splits - guiding and retention of splits - mould plate designs - split designs, Operation of Splits-Finger cam actuation -Dog leg actuation - Cam track actuation -Spring actuation -Hydraulic actuation, Split locking method - Open channel type - Closed channel type, Split safety arrangement - Spring detente method - spring loaded method. **Side core and side cavity-** Selection of side core and side cavity design for the required components - Integral side core or side cavity, Assembly details - Construction - guiding arrangement, Method of actuation - Methods used in actuating the side core and side cavity.

07Hrs

Text Books:

1. Introduction of injection mould design - Pye

Course code: 17VT402 Total Hours: 30 hrs	PRODUCTION TECHNOLOGY - IV	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students to have: 1. Knowledge in health, safety and security at the workplace. 2. Knowledge in Non-conventional machining. 3. Awareness about basic practices that improve effectiveness of working with others in an organizational set-up				
Course Outcomes	Students after the completion of this course will be able to: 1. Take the basic precautions and simple control measures that can be implemented to reduce the risk of fire in workplace. 2. Proper use of safety devices,				

Reference Books:

1. All about Plastics-NI George
2. Die Moulds and Jigs - V.Vladimir
3. Plastic material & Process - Schwartz

Module 1

Health and safety – Protective clothing/Equipment, Hazards, Safe working practices, Methods of accident prevention, Good housekeeping practices at various areas. **Fire safety -** Types of fires, Rescue techniques applied during fire hazard, proper housekeeping in order to prevent fire hazards, correct use of a fire extinguisher. **Emergencies, rescue and first-aid procedures -** Appropriate first aid to victims were required e.g. in case of bleeding, burns, choking, electric shock, poisoning etc., organize loss minimization or rescue activity during an accident in real or simulated environments, Emergency procedures: raising alarm, safe/efficient, evacuation, correct means of escape, correct assembly point, roll call and correct return to work, Accident/incident report. (Incident Report includes details of: name, date/time of incident, date/time of report, location, environment conditions, persons involved, sequence of events, injuries sustained, damage sustained, actions taken, witnesses, supervisor/manager notified), Correct method to move injured people and others during an emergency.

07 Hrs

Module 2

Non-conventional machining - Chemical machining: principle of operation-chemical milling - chemical blanking - chemical engraving, Ultrasonic machining: Working principle of the machine tool material and tool size - application of ultrasonic machining, Water jet Machining, Abrasive jet machining: Principle of operation - element and the influence of the process - application of the process, Laser beam machining: Principle of these machining –machining process – applications, Electron beam machining: Working principle of the EBM - process of the machining - application of the process, Plasma arc machining: Principle of plasma arc machining – different parts of the machine – application of the process, Ion Beam machining: Principle of the machining - different parts of the machine – applications.

06 Hrs

Module 3

Working effectively with others at work - Accurately receive information and pass on information to authorized persons who require it and within agreed timescale and confirm its receipt, display appropriate communication etiquette while working (Communication etiquette: do not use abusive language; use appropriate titles and terms of respect; do not eat or chew while talking (vice versa) etc., Demonstrate responsible and disciplined behaviors at the

workplace. (Disciplined behaviors: e.g. punctuality; completing tasks as per given time and standards; not gossiping and idling time; eliminating waste, honesty, etc.), Escalate grievances and problems to appropriate authority as per procedure to resolve them and avoid conflict.

07 Hrs

Module 4

Machine tool Maintenance - Importance of maintenance of machine tools, Types of maintenance - Preventive - Break down. **Additive manufacturing -** Introduction to additive manufacturing, Benefits of additive manufacturing, Functional principle of AM.

05 Hrs

Module 5

Micro and Nano Manufacturing - Introduction to Micro and Nano manufacturing technology, advantages and applications of nanotechnology, Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, Chemical Vapor Deposition, Physical Vapor Deposition, etching, and material modification methods, processes and equipment.

05 Hrs

Text Books:

1. Kalpak Jain, Manufacturing Engineering & Technology, Addison Wesley,1997
2. Poul De Garmo, J.T.Black, R.A.Kosher, Materials and Processes in Manufacturing, Prentice Hall of India, 1997.
3. Gibson, I., Rosen, D.W. and Stucker, B., Additive Manufacturing Methodologies: Rapid Prototyping to Direct Digital Manufacturing, Springer, 2010.

Reference books:

1. Modern W/s Technology - Wright Baker
2. All about machine tools - H. Gerling
3. Workshop Technology (Part I - Part III) - Chapman
4. Machine Technology Vol.1 – Vol.4 - P.M Johnston
5. Production Technology - Jain, Agarwal

		L	T	P	C
Course code: 17VT403 **Total Hours: 30 hrs**	**STRENGTH OF MATERIALS-II**		-	-	**2**
Course Objectives	The objective of this course is to enable students : 1. To provide knowledge on bending stress and torsion on materials 2. To understand the stresses developed in bars, compounds bars, beams, shafts. 3. To analyze the stress and strain on mechanical components. 4. To identify and quantify failure modes for mechanical parts				
Course Outcomes	Students after the completion of this course will be able to : 1. Apply concepts of strength of materials to obtain solutions to real time Engineering problems 2. Ability to understand different kinds of loading in mechanical engineering components. 3. Ability to apply the fundamentals of mechanics of solids, stress analysis, theories of failure and material				

Module 1

Bending stress - Introduction: importance in tool engineering, Revision on Equilibrium of forces and moment of a force, Moment of inertia, Centre of gravity and centroid. Introduction to Beams, Types of beams and Loads acting on beams, Problems on cantilever and simply supported beams - theory of simple bending - bending stress - position of neutral axis - section modules - M/I= F/Y =E/R – Problems using bending equation.

06 Hrs

Module 2

Torsion of shaft - Shafts - function of shaft – Introduction to rigidity modulus, effect of torque on a shaft - twisting movement - Torsional stress, Torsional rigidity, strength of a shaft - polar moment of inertia - power transmitted by a shaft - angle of twist – Torsional equation, Problems using torsional and power transmitted by shaft.

06 Hrs

Module 3

Torsion of Springs - Types of springs - bending spring - torsion spring, Forms of springs - leaf spring - helical springs - closely coiled helical spring- open coiled helical spring-

compound spring - springs in series - springs in parallel, Closely coiled helical spring subjected on axial load - closely coiled helical spring subjected on axial twist - calculation of number of turns - open coiled helical, Spring subjected in axial load-open coiled helical spring subjected to axial twist - bending stress - deflection of spring Problems on helical springs.

06 Hrs

Module 4

Static Strength - Static loads and factor of safety. Theories of failure- maximum normal stress theory, maximum shear stress theory, maximum strain theory, strain energy theory, distortion energy theory. Failure of brittle and ductile materials, stress concentration, determination of stress concentration factor.

06 Hrs

Module 5

Fatigue Strength - Introduction, S-N Diagram, low cycle fatigue, high cycle fatigue, 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. **06Hrs**

Text Books:

1. Hibbeler, R.C., "Mechanics of Materials", Pearson Education, 2007.
2. Joseph E Shigley and Charles R. Mischke, Mechanical Engineering Design, McGraw Hill International edition, 6th Edition 2009.
3. V.B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

Reference books:

1. Bansal, R.K., "Strength of Materials", Laxmi Publications (P) Ltd., 2007. 2. S.S Rattan, “Strength of Materials”, Tata McGraw Hill, 2009.

Course code: 17VT404 Total Hours : 30 hrs	PRESS TOOL TECHNOLOGY-II	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to make the students : 1. Ability to design Progressive Tools. 2. Comparison between Progressive tool & compound tool. 3. Highlight the design aspect of bending tool.				
Course out comes	Upon successful completion of this course, the trainee will be able to: 1. Explain the elements of compound tool. 2. Compare between Progressive tool & compound tool. 3. Describe the design aspect of deep drawing.				

Module 1

Compound Tool- Function of elements – Design of compound tool, Comparison of Progressive tool & Compound tool. Bending- Principals of bending, Plastic deformation due to bending, Bending elements.

05 Hrs

Module 2

Blank length – calculation of original length of strip required for bent component- formula for calculating- Developing the blank size, bending radius – calculation of maximum and minimum radius, bending force – bending force for "V" bending dies, bending force for "U" bending dies.

06 Hrs

Module 3

Spring back – spring back in "V" bending dies. – Over bending- Corner setting- off set punch method angular punch relief, spring back in "U" bending dies- Remedies.

05 Hrs

Module 4

Stripping U bends – spring actuated plungers- hook strippers- positive knock off, Effects of grain direction on bending.- effects of burr side- bending in proximity to pierced holes, Materials for bending, Types of bending tools- elements- design- "V" bending dies- "U" bending dies- L bends on pressure pad dies- bending dies in press brakes- Rotary bending.

07 Hrs

Module 5

Deep drawing- Describe deep drawing- design of a draw tool, elements of draw tool, function of each element, Deep drawing of a cylindrical cup- explain, Force acting on a component while drawing, Metal flow during drawing a cylindrical cup, Wrinkling and Puckering- differentiate wrinkling and puckering.

07 Hrs

Text Books:

1. Tool Design – Donaldson
2. Die Design Fundamentals – Paquin

Reference Books:

1. Basic Die Making - Ostergarrd
2. Advanced Die Making – Ostergarrd
3. Tool Design - C.B Cole
4. Punches and Dies - Frank A Stanley
5. Fundamentals of Tool Design - A.S.T.M.E

Course code: 17VT405	PNEUMATICS & HYDRAULICS	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students : 1. Appreciate the fundamental principles of Fluid Mechanics 2. Study of working principle of various components used in hydraulic and pneumatic systems. 3. Select different components used in hydraulic and pneumatic systems. 4. Design of hydraulic and pneumatic circuits. Understand industrial applications of hydraulic and pneumatic circuits.				
Course Outcomes	Students after the completion of this course will be able to : 1. Understanding operating principles and constructional features of hydraulic and pneumatic systems. 2. Knowledge with selection of hydraulic / pneumatic components. 3. Understanding of designing and layout of Hydraulic Power package and trouble shooting.				

Module 1

Pneumatic power - application advantages & dis-advantages, Hydraulic power- mechanical power vs. fluid power in transmission – applications - advantages and disadvantages. Properties of fluid - Common properties of fluids: Density - specific volume - specific weight - relative density - pressure atmospheric, gauge, absolute pressure – viscosity, Hydrostatics: Determination of pressure at a depth below free surface of a liquid - Pascal's Law - definition - applications - hydrostatic paradox, Hydro Dynamics: Bernoulli's Equation - statement -practical -application Law of volume of flow (continuity equation), Gas Laws: Boyle's Law - Charle's Law - Gay-Lussac's Law - numerical problems applying Gas Laws.

06 Hrs

Module 2

Production of Compressed air - Characteristics of compressed air: Positive characteristics - negative characteristics, Types of compressors: Positive displacement compressors - reciprocating piston compressor - diaphragm compressor - rotary piston compressor -two axle screw compressor – roots blower - Flow compressors: axial flow compressor - radial flow compressor, Terms associated with compressor: delivery volume-theoretical - effective-working pressure-operation, Drives for compressors: electrical motor - IC engine, Cooling of the compressors: need - methods - cooling fins - fans - fresh water cooling, Regulation of compressors: no load regulation - low speed regulation - on/off regulation, Compressed air receiver: necessary of compressed air receiver - selection of compressed air receiver - delivery volume - pressure -drive - cooling method- regulation - determination of air receiver size.

06 Hrs

Module 3

Preparation & distribution of compressed air - Compressed Air Preparation: Necessary for the preparation of compressed air - functions of suction filter - functions of intercooler and recooler - necessity of drying compressed air -drying process -absorption drying - adsorption drying - low temperature drying-functions of air filter- requirements of air filter- functioning of pressure regulators- with vent hole - without vent hole - functions of compressed air lubricator - functions of service unit (FRL), Distribution of compressed air: system of distribution of compressed air - criteria for selecting pipe diameter - flow volume - pipe length - pressure drop - working pressure - number of restrictions in the pipe line - pipe diameter calculation- pipe material-types of line and tube connectors.

06 Hrs

Module 4

Pneumatic working elements - Pneumatic cylinders: constructional details and working of: SAC - diaphragm cylinder - rolling diaphragm cylinder- DAC - cylinders with end position cushioningcylinders with double sided piston rod-cylinders with double sided piston - tandem cylinder- multiposition cylinder - impact cylinder - rotary cylinder - constructional features of pneumatic, Cylinders - calculation for cylinders - piston force - air consumption, Pneumatic motors: characteristics of pneumatic motor - working of- sliding vane motor-gear motors- turbine motors, Pneumatic valves: constructional details and functioning of: directional valves-non- return valves- pressure control valves- shut off control valves-quick exhaust control valves - sequence control valves - time relay control valves - representation of pneumatic valves with symbols. Basic pneumatic circuits - Symbols used in pneumatics (ISO 1219/DIN 24300) - design of basic pneumatic circuits employing SAC - design of basic pneumatic circuits employing DAC - rigging up circuits.

06 Hrs

Module 5

Hydraulic working elements - Hydraulic pumps: Constructional details of gear pump - functions of gear pump, Hydraulic cylinders: constructional details and working of SAC-DAC with double piston rod- with end position cushioning - telescopic cylinders - tandem cylinder - determination of force developed by cylinders, Hydraulic motor: working of basic model of hydraulic motor - working of cam type axial piston motor, Hydraulic filters: functions of filter-air breather filter -suction line filter pressure line filter-return line filter, Hydraulic valves: construction and functions of: pressure relief valve - directional valve - flow control valve - representation of various hydraulic valves with symbols. Basic hydraulic circuits - Symbols used in hydraulics (ISO 1219/DIN 24300) - design of basic hydraulic circuits employing DAC - design of basic hydraulic circuits employing DAC - rigging up circuits. Hydro-pneumatic systems - Principles of hydro-pneumatic systems- advantages – pressure converter - pressure intensifier - functions of feed units - functioning of hydraulic accumulators - functioning of hydraulic intensifier, Electro-pneumatic system. - Principles – advantages.

06 Hrs

Text Books:

1. Majumdar, S.R., “Oil Hydraulics Systems- Principles and Maintenance”, Tata McGraw Hill,2001
2. Majumdar, S.R., “Pneumatic Systems – Principles and Maintenance”, Tata McGraw Hill, 2007.

Reference books:

1. Anthony Esposito, “Fluid Power with Applications”, Prentice Hall, 2009.
2. Shanmugasundaram.K, “Hydraulic and Pneumatic Controls”, Chand & Co, 2006.
3. Dudelyt, A Pease and John J Pippenger, “Basic Fluid Power”, Prentice Hall, 1987.

4. Srinivasan.R, “Hydraulic and Pneumatic Controls”, Vijay Nicole Imprints, 2008.

Course code: 17VT407 Total Hours: 90 hrs	WORKSHOP-IV	L	T	P	C
			-		8
Course Objectives	The objective of this course is to enable students : 1. Able to understand the building of a bench fixture. 2. Able to cut thread on engine lathe 3. Able to cut left hand and right-hand thread 4. Able to cut different forms of thread. 5. Able to grind the end mill cutter 6. Able to file a bevel edge. 7. Able to do Profile filing.				
Course outcomes	Students after the completion of this course will be able to: 1. Work independently on manufacturing of elements such as Bench fixture, Base Plate, Handle, Guide Plate, Cam, Cam Post and Bending Die. 2. Assembly of progressive tool.				

LIST OF EXPERIMENTS

1. **Manufacturing of elements-** Bench fixture, Base Plate, Handle, Guide Plate, Cam, Cam Post and Bending Die.
2. **Manufacturing of elements –** Spindle, Tool & Cutter, Try Square and Straight Edge.
3. **Manufacturing of elements of Progressive Tool-**Guide bush and guide pillar.
4. **Assembly of Progressive Tool**

Course code: 17VT408 Total Hours: 90 hrs	TOOL DESIGN DRAWING-II	L	T	P	C
			-		6
Course Objectives	Students after the completion of this course will be able to: 1. Training in the ability to design Progressive Tools. 2. Training in the ability to design different types of Compound Tools. 3. Training in the ability to design different types of bending tools. 4. Training in the ability to design a Drawing tool. 5. Training in the ability to design a Hand injection mould.				
Course outcomes	Students after the completion of this course will be able to: 1. Design the Progressive tool. 2. Design the Compound Tool, bending tool and drawing tool. 3. Design an Injection mold.				

LIST OF EXPERIMENTS:

1. **Design of Progressive Tools-** Design a progressive tool with travelling stripper, Design a progressive tool with side cutter and travelling stripper, Design a progressive tool incorporating parting off operation.
2. **Design of Compound Tools-** Design a compound tool with direct knock out mechanism, Design a compound tool with indirect knock out mechanism.
3. **Design of Bending Tool**- Design a 'V' bending tool, Design a 'L' bending tool, Design a 'U' bending tool, Design a 'Z' bending tool.
4. **Design of Drawing Tool-** Design a draw tool with mechanical blank holding, Design a draw and pinch trim combination tool.
5. **Design of Hand injection mould-** Design of a single cavity Hand Injection mould.

Course code: 17VT409 Total Hours: 90 hrs	PNEUMATICS & HYDRAULICS LAB	L	T	P	C
			-		6
Course Objectives	Students after the completion of this course will be able to: 1. Carry out experiments on single acting cylinders for pneumatic systems 2. Conduct experiments on control of double acting cylinders and study different control mechanisms for pneumatic systems 3. Conduct experiments on hydraulic switches 4. Carry out experiments on hydraulic accumulators 5. Conduct experiments to simulate pneumatic and hydraulic circuits using PLC				
Course outcomes	Students after the completion of this course will be able to: 1. Demonstrate the skills to conduct the experiments on hydraulic and pneumatic systems 2. Design and simulate the hydraulic and pneumatic circuits using PLC				

PNEUMATICS

LIST OF EXPERIMENTS:

Exercise 1: Direct and indirect control of a single-acting cylinder, extending

Exercise 2: Direct and indirect control of a double-acting cylinder with pushbutton

Exercise 3: Signal storage by means of contactor contacts

Exercise 4: Controlling a double- acting cylinder, impulse valve, 2 push-buttons

Exercise 5: Displacement dependent control of a double acting cylinder, impulse valve

Exercise 6: Pressure-dependent control of double-acting cylinder

Exercise 7: Time-dependent control of double-acting cylinder

Exercise 8: Holding-element control of a double-acting cylinder with impulse

Exercise 9: Displacement-dependent control of a double-acting cylinder, impulse valve, cylinder switch

Exercise 10: Sequential control of 2 double-acting cylinders with impulse valves and signal overlapping

Exercise 11: Sequential control of 2 double-acting cylinders with spring return valves and step sequence.

30 Hrs

HYDRAULICS

LIST OF EXPERIMENTS:

Exercise 1: Extending a cylinder by operating a push button

Exercise 2: Signal storage by electrical self-locking, setting and resetting using a momentary-contact switch

Exercise 3: Mechanical locking by means of momentary-contact switch contacts

Exercise 4: Electrical locking by means of contactor contacts

Exercise 5: Signal storage by means of contactor contacts

ACCUMULATOR

Exercise 6: Accumulator applications

Exercise 7: Pressure switches and proximity switches

Exercise 8: Advance control with time-dependent intermediate stop

30 Hrs

PROGARAMMING LOGIC CONTROLLER

LIST OF EXPERIMENTS:

Exercise 1: Displacement control of Pneumatic cylinders by PLC logic

Exercise 3: Sequential Control of 2 cylinders by PLC logic

Exercise 4: Sequential Control of 2 cylinders by PLC logic

Exercise 5: Sequential Control of 3 cylinders by PLC logic

Exercise 6: Sequential Control of 2 cylinders with time delay by PLC logic

Exercise 7: Sequential Control of 2 cylinders with time delay and counter by PLC logic

Exercise 8: Sequential Control of 2 cylinders with time delay and counter by PLC logic

30 Hrs

Course code: 17VT501 Total Hours: 45hrs	PRESS TOOL TECHNOLOGY-III	L	T	P	C
			-	-	3
Course Objectives	The objective of this course is to enable students : 1. Familiarization with different forming operation 2. Knowledge in shaving operation 3. Highlight the design aspect of fine blanking. 4. Highlight the design aspect and use of unit tooling 5. Highlight the importance of transfer press in large scale manufacturing. 6. Awareness in the design of forging tool. 7. Understanding the different types of tooling materials and its application. 8. Recap the basic fundamentals of press tool building				
Course Outcomes	Students after the completion of this course will be able to : 1. Understand Forming and shaving 2. Explain Fine blanking and Unit Tooling 3. Understand the criterion in the selection of tool material				

Module 1

Forming and Shaving: Embossing - Describing embossing – need, Coining - Describe coining – need, Curling - Describe curling – need Curling - Describe curling – need, Flanging –Describe flanging –diameter of hole to be pierced for flanging – height of flange, Planishing –Describe planishing-need –method. Shaving process – purpose of shaving, shaving clearance-punch and die size of shaving. Shaving allowance –Calculate allowance for shaving, shaving direction – Decide the shaving direction – blank size before shaving

10Hrs

Module 2

Fine blanking and Unit Tooling-Explanation of term – Application of fine blanking Working principle – Explain working principle of fine blanking tool – Ring – Function of V – Ring – from die aperture, Strip width and margin-Importance of strip width and margin –calculation, Press Force-Calculation of press force for fine blanking. Unit Tooling: Angular piercing- working- application- function, Arial cam- working – application –function, Combination tool-differentiate combination tool and compound tool

10Hrs

Module 3

Forging and Extrusion- forging operation- billet preparation and heating- sizing of forging parts, Cold forging- coining-minting-elements-function. Extrusion Tool: Working – design – elements- function.

07hrs

Module 4

Tooling Materials-Reason for case hard steel used for pillar and bush- Alloy materials (full hard) used as punches and dies- essential alloys required in steels used for cutting operation –Essential alloys required in steel used for forming and bending operation. **08Hrs**

Module 5

Press Tool building fundamentals-Recap of the shearing theory, cutting force, Punch and die clearance, punch and pilot height relation, stripper & pilot height relation, relationship of the part to the die and punch sizes, difference between Cut off & parting off operation, ball lock punch & ball lock punch holders, stripper windows and advantages, nitrogen gas springs and difference between a part produced from progressive and compound tool.

10Hrs

Text Books:

1. Tool Design – Donaldson
2. Die Design Fundamentals – Paquin

Reference Books:

1. Basic Die Making - Ostergarrd
2. Advanced Die Making – Ostergarrd
3. Tool Design - C.B Cole
4. Punches and Dies - Frank A Stanley
5. Fundamentals of Tool Design - A.S.T.M.E

Course code: 17VT502 Total Hours: 45hrs	MOULD TECHNOLOGY-II	L	T	P	C
			-	-	3
Course Objectives	The objective of this course is to enable students : 1. Highlight the design of molds having internal undercuts and threads. 2. Understand the design of multi daylight mold. 3. Familiarization in the design of runner less molds and hot runner mold. 4. Familiarization with the common injection molding defects. 5. Understand the design of compression mold and its parameters. 6. Understand the design of Transfer mold and its parameters 7. Familiarization of process description of die casting. 8. Familiarization with different plastic processing methods other than injection molding.				
Course outcomes	Students after the completion of this course will be able to : 1. Understand different molding methods used in internal undercuts 2. Compare between single daylight and multi daylight mold 3. Explain compression molding				

Module 1

Mould for internal under cuts and threads: Different methods used in moulding internal undercuts - form pin - straight action form pin - angled action form pins - split cores - split core with straight and angled action -side cores. Stripping internal under cuts, Mould for threaded components - Method used - Fixed thread core design. Stripping threaded components -Loose thread core-Unscrewing mould - rotating cavity -moulding for external threaded component.

10 Hrs

Module 2

Multi-daylight mould and Runner less mould- Differentiate between single daylight mould and multi-daylight mould. Underfeed moulds - Function of under-feed mould - basic underfeed mould – operation cycle Types of feed: Secondary sprue gate-Reverse taper secondary sprue -Undercut runner system -runner stripper plate design - design feature, Triple daylight mould - Identify triple daylight mould. Runner less mould- Describe Runner less mould - four types of nozzles used in Runner less mould. Hot runner mould - different types of hot runner units - Describe hot runner mould - different types of hot runner units.

10Hrs

Module 3

Injection moulding defects and Compression moulding -shot fills, flow marks, silver streaking, poor weld lines, voids, sink marks, warpage. Compression moulding-Compression moulding process-compression moulding procedure-mould temperature press closing speed-degassing or breathing-final cure time Compression mould: vertical flash/horizontal flash designs. **09Hrs**

Module 4

Transfer moulding and Die casting- Transfer mould procedure-Advantages/disadvantages of it. Moulding cycle- tighter

dimensional tolerances- insert moulding, Pot transfer mould- Plunger transfer mould-Runner-Gate- Vents.Die casting-Process description – hot chamber process- cold chamber process. Process other than injection moulding of thermoplastics-Blow Moulding-Thermoforming-Rotational Moulding-Extrusion-Calendaring.

09Hrs

Module V

Additives for plastics-Fillers, Antioxidants, thermal stabilizers, lubricants, plasticizers, fire retardants, blowing agents, Impact modifiers, mixing and compounding equipment's. **07Hrs**

Reference books:

1 Introduction of injection mold design - Pye
2 All about Plastics- NI George
3 Die Molds and Jigs - V. Vladimir
4 Plastic material & Process – Schwartz

Course code: 17VT503 Total Hours: 30hrs	PRODUCTION MANAGEMENT CONTROL	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students : 1. Understand the evolution and revolution of business and industry and their classification. 2. Highlight the factors to be considered in the site location and plant lay out 3. Highlight the importance of Production planning and control and its procedure. 4. Awareness on material management, purchase organization, store keeping and inventory control. 5. Familiarize the trainee with production, productivity and management techniques. 6. Awareness of lean manufacturing system.				
Course outcomes	Students after the completion of this course will be able to : 1. Understand Industry Nature and evolution of business development 2. Differentiate between different types of business organizations				

Module 1

Industry Nature and Evolution of Business Development of Commerce: household economy – primitive barter economy-the rise of trade- protected trade centres - town economy - international trade. Types of business organization. Private Sector: individual ownership - partnership - joint stock company - cooperative organizations. Public sector: departmental organizations - public corps or statutory cos. -government cos. Joint Sector: Ownership and control shared by private entrepreneur, state and Public Commercial business: Banking - transport - insurance - Trade: internal and international - warehousing - packing - advertising. Evolution of Industry: Historic background.

06Hrs

Module 2

Industrial Revolution: Historic background - two major changes - six great changes or development - results of industrial revolution. Economic consequences / social and political consequences/machine age and the factory system / industrial change and business management/technology and industrial change. Classification of Industry**:** Broad classification: extractive industry –genetic industry - construction industry - manufacturing industry - on the basis of size and investment: large scale industries (heavy industry), medium scale industries(medium industries), small scale industries (light industries) - cottage industries- By the type of product : metallurgical /fuel/boilers/prime movers/electrical equipment's/telecom etc. Types of manufacturing industry: Continuous type: mass production - flow production Intermittent type: job order production - batch order production Examples for each/advantages and disadvantages

06Hrs

Module 3

Layout: Site selection of a factory: - introduction - factors to be considered in general location of the factory - factors to be considered in the selection of a particular site, Factory layout (plant buildings) : - introduction – major considerations which should be followed while making layout of any kind of factory. Plant Layout: - introduction - principles of plant layout - factors influencing plant, layout - methods of layout - line or product

layout/functional or process layout, fixed position layout/combination layout - advantages and disadvantages, Flow pattern: Factors governing flow pattern-flow systems: horizontal flow lines (five basic types) - vertical flow lines (six basic types)

06Hrs

Module 4

production planning & control, Material management: Introduction – understanding PPC,Sales forecasting: Definition and concept Process planning: Definition and concept- information require to do processing planning- process planning procedure, Dispatching: Introduction dispatch procedure- centralized and decentralized dispatching, Routing: introduction – routing procedure materials, purchase, stores and inventory management. Material management: functions of material management- objectives of material Management Purchase organization: objectives of purchasing department- activities, duties and functions of purchasing department- purchase procedure .Stores and store keeping: : purpose of storekeeping, duties of store keeper- store location- methods of storing- protection of stores- stock stacking system. Inventory control: inventory classification- objectives and how to achieve them –function of inventories- economic order quantity- ABC analysis. Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods. CPM & PERT- project scheduling, critical path calculations, Crashing, job sequencing.

06Hrs

Module 5

production and productivity management techniques-Production and productivity: Understanding production and productivity- measures to increase productivity, Quality control: inspection and quality control- kinds of inspection- statistical quality
control (SQC)- sampling inspection- control charts and their applications.
Quality circle (QC): what is quality circle- origin of quality circle- structure of quality
circle. Operation of quality circle. “KAIZEN” – understanding “KAIZEN”- objectives of kaizen. ‘ KANBAN”- the” JUST IN TIME”; management system; introduction to kanban
Introduction of TPM & TQM. LEAN MANUFACTURING SYSTEM Lean manufacturing concept to analyze different kind of waste in production system and give methods of minimize the waste and increase efficiency

06Hrs

Reference books:

1. Industrial organization and management- Sundaramurthy
2. Fundamentals of business organization - Y K Bushan
3. Store keeping - Ananthakrishnan
4. Plant layout and material handling - G Chandrasakaran
5. Factory organizations and principles of management – K Ahiya
6. Industrial engineering - M Ponnuswamy
7. Industrial engineering and management sciences - Banga, Agarwal

Course code: 17VT506 Total Hours: 90 hrs	TOOL DESIGN DRAWING-III	L	T	P	C
			-		6
Course Objectives	The objective of this course is to make the students understand : 1. Ability to design injection molds 2. Ability to design injection molds with various types of Ejection mechanisms 3. Ability to design injection molds with split cavities. 4. Ability to design injection molds with delayed opening. 5. Ability to design a three-plate mold with simple mechanism				
Course Outcomes	After successful completion of the course, the students should be able to : 1. Design all the elements of injection mold 2. Design a two-plate injection mold with split cavity and side core				

LIST OF EXPERIMENTS

TOPICS
Design of injection mold base.
Design of 2 plate injection mold
Design of inj mold with sleeve ejection
Design of inj mold with stripper plate ejection.
Design of **split cavity** inj mold with sleeve ejection
Design of split cavity injection mold with **dog leg** cam.
Design of mold with **side core**
Design of mold with **split cores**
Design of molds having **threads**. – Collapsible core

Course code: 17VT507 Total Hours: 90 hrs	WORKSHOP-V	L	T	P	C
		-	-	-	6
Course Objectives	The objective of this course is to enable students : 1. Understanding the concepts of different operations such as Bench work, milling and Turning. 2. Understanding the concepts of different operations such as surface grinding and cylindrical grinding.				
Course Outcomes	Students after the completion of this course will be able to: 1. Work independently on different operations such as Bench work, milling, Turning, surface grinding and cylindrical grinding.				

LIST OF EXPERIMENTS

1. **Manufacturing of elements of Hand Injection Mould -** Top Plate, Cavity plate, guide pillar.
2. **Manufacturing of elements of Hand Injection Mould -** Bottom plate, core plate, actuating rod.
3. **Manufacturing of elements of Hand Injection Mould –** stripper plate, core and assembly

Course code: 17VT508 Total Hours: 90 hrs	INJECTION MOLD AND PRESS TOOL DESIGN USING CATIA	L	T	P	C
		-	-	-	6
Course Objectives	The objective of this course is to make the students understand : 1. Part modelling of Progressive Tool 2. Assembly of Progressive Tool 3. Part modelling of 2 plate injection mold 4. Assembly of 2 plate injection mold				
Course Outcomes	After successful completion of the course, the students should be able to : 1. 3D modelling and assembly of Progressive Tool and 2 plate injection mold.				

LIST OF EXPERIMENTS

PRESS TOOL DESIGN
Part modelling of Progressive Tool- Top plate, Bottom plate, Punch back plate, Punch holder, Punch.
Part modelling of Progressive Tool- Stripper plate, Stripper back plate, Die plate, Die back plate, Die.
Part modelling of Progressive Tool- Strip guide spacer, Strip guide holder, Guide pillar, Guide bush.
Assembly of Progressive Tool- Assembly of top half and bottom half.
INJECTION MOLD DESIGN
Part modelling of 2 plate injection mold - Top plate, Sprue bush, Cavity plate, Cavity insert, Locating ring, Guide pillar.
Part modelling of 2 plate injection mold – Bottom plate, Core plate, Core insert, Guide bush, Ejector plate, Ejector back plate, Spacer.
Assembly of 2 plate injection mold - Assembly of top half and bottom half.

Course code: 17VT511 Total Hours: 30hrs	ADVANCED MOLD TECHNIQUES	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students : Student should be able to 1. Understand the techniques for manufacturing of plastic components 2. Outline the significance of blow molding and RIM. 3. Analyze components of extrusion coating. 4. Understand the concept of PTFE molding.				
Course outcomes	Students after the completion of this course will be able to: 1. Understand Injection molding, Extrusion, Lamination, Blow molding and special molding techniques. 2. Analyze the plastic components and challenges in selection of feed system. 3. Apply the engineering knowledge for the selection of type of mound for plastic components. 4. Design and evaluate the effects of mold on the components.				

Module1

Future trends in injection molding-Molding of cellular product like EPS, steam chest molding, future trends in injection molding like external & internal inter locking alignment of large molds, processing of specialty polymers.

06Hrs

Module 2

Blow Molding-Working principle of blow molding machine, injection stretch blow molding of PET, precut molding, multi-layer blow molding. **06Hrs**

Module3

Reaction Injection Molding and LSR molding-RIM of Polyurethane, material for RIM, liquid RIM & its advantages over conventional injection molding. LSR-process, equipment, characteristics of LSR, advantages of LSR.

06Hrs

Module4

Lamination-Lamination by extrusion coating, twin screw extrusion, co-rotating & counter rotating, feeding mechanism in twin screw extruder, principles of compounding, mixing mechanism etc.

06Hrs

Module 5

PTFE Molding-Processing techniques used for PTFE, Material consideration, sintering, Ram extrusion and Paste extrusion, advantages of PTFE processing. **06Hrs**

Text Books:

1. Injection Moulding, Theory and Practice by Irvin I. Rubin. Wiley-Interscience, ISBN-13: 978-0471744450
2. Extrusion Die Design, M. V. Joshi. PublisherMacmillan Publishers India LtdISBN-13: 9780333904497
3. Polymer Extrusion 5E, Rauwendaal, C. New York, Hanser Publications ISBN: 9781569905166

4. Blow Molding Handbook: Technology, Performance, Markets, Economics: The Complete Blow Molding Operation, Dominick V. Rosato, Hanser Gardner Publications (ISBN13: 9781569903438) 2003.

Course code: 17VT601 Total Hours: 45 hrs	PRESS TOOL TECHNOLOGY-IV	L	T	P	C
			-	-	3
Course Objectives	The objective of this course is to enable students : 1. Ability to design the punch considering the strength and stability required for cutting. 2. Knowledge in the development of blank sizes for drawing operation and the force required to draw. 3. Knowledge in the Statistical Process Control. 4. Knowledge in popular issues and remedy that occur in stamping operation. 5. Knowledge in the getting maximum life out of a Press Tool. 6. Knowledge in the Advanced multistage tooling involving multiple operations				
Course Outcomes	Students after the completion of this course will be able to : 1. Explain the design of punch considering the strength and stability required for cutting. 2. Analyze the development of blank sizes for drawing operation and the force required to draw. 3. Explain the Advanced multistage tooling involving multiple operations.				

Module 1

Buckling of punches and deep drawing- Buckling theorem – problems - types of loads acting on punches- determining the size of punches. Blank development of a cylindrical shells- necessity for determining the blank diameter for the cylindrical shells - development of blank using the algebraic method - using graphical method. Drawing Force- Explain drawing force – method for calculating drawing force for a cylindrical cup. Press capacity**.** Blank holding Force- calculation method for blank holding force. Clearance- importance of clearance- formula to calculate clearance for deep drawing-calculation. Die Punch radius- importance of die and punch radius. Draw beads- importance of draw beads- types of beads. Air vents- importance of air vents- methods of providing.

10Hrs

Module 2

Deep drawing and its types- Number of draws- height of the cup at each stage. Diameter at each stage- Consideration of d/D ratio- consideration of percentage reduction. Drawing flanged components- determination of number of draws calculation. Metal flow in a rectangular shell - describe- blank development of rectangular shell using graphical method. Faults occurring deep drawing- faults on material, equipment and design of tools-faults in maintenance and setting tools- remedies- necessity of annealing in between draws (intermediate annealing). Reverse draw. Ironing. Eyelet drawing – describe eyelet drawing- calculation of number of draws.

10Hrs

Module 3

Acceptance of tools in process capability-Process capability of tools- chance cause and assignable cause. Tolerance on components- characteristic to consider during design- special characteristics - USL & LSL and USL & UCL. Production run of tools – uninterrupted production run- record results of identifying sp. Characteristic. Calculate process capability in terms of Cp & Cpk. **10Hrs**

Module 4

Tool failures- Determining factors of tool failures-slug jamming- press selection-knife edge error in designing die block and punch. Slug pulling and the remedies. Breakage of die plates and repair-welding, stitching, nesting etc.

08Hrs

Module 5

Factors Effecting Tool Life and advanced multistage tooling - Introduction. Elements of tool performance – wear of punch and die block- side wall finish- excessive wear-die block life calculation. Application and advantages in doing different types of operation in a single tool progressively.

07Hrs

Text Books:

1. Die Design Fundamentals - Paquin
2. Tool Design - Donaldson
3. Basic Die Making - Ostergarrd

Reference Books:

1. Advance Die making. - Ostergarrd
2. Tool Design - C.B Cole
3. Punches and Dies - Frank A Stanley
4. Fundamentals of Tool Design - A.S.T.M.E

Course code: 17VT602 Total Hours: 45 hrs	MOULD TECHNOLOGY-III	L	T	P	C
			-	-	3
Course Objectives	The objective of this course is to enable students : 1. Highlight the importance of mould Polishing. 2. Appreciation of the factors effecting mould service life and Mould Maintenance. 3. Familiarization in the design of injection moulding of Thermosets. 4. Awareness on different Surface treatment methods of Plastic. 5. Familiarization of the Die casting Die. 6. Familiarization of Flow systems of die casting. 7. Knowledge about the various Defects and remedies in die casting. 8. Familiarization of Product development. 9. Familiarization of Metal injection moulding.				
Course Outcomes	Students after the completion of this course will be able to : 1. Understand the importance of mould Polishing and factors effecting mould service life and Mould Maintenance. 2. Explain the design of injection moulding of Thermosets. 3. Explain the concept of Product development and Metal injection moulding.				

Module 1

Polishing and factors effecting mould service life-Importance of mould polishing. Importance of mould finishing – Chrome plating – advantages of chrome plating – practical hints – Sequence of lapping and polishing of mould parts. Mechanical design – grade of tool steel – Machining procedure – heat treatment – grinding – handling. Mould maintenance – break down maintenance – Mould history card – Preventive maintenance based on wear due to moulding.

09Hrs

Module 2

Injection moulding of thermoset plastics and Surface Treatment of plastics- Injection moulding of thermosets – describe the working of injection moulding of thermosets – Advantages and disadvantages of direct screw transfer moulds. Mould design – process of injection moulding of thermosets – mould heating - sprue – runner – gate – venting – condition of injection moulding of thermosets – counter pressure – injection pressure – hold on pressure – curing time. Screen printing – hot stamping – heat transfer decoration – two color moulding – electroplating of plastics – vacuum metalizing of plastics. **09Hrs**

Module 3

Die casting Die and flow systems of die casting- Basic terminology- elements of mould – function – Fixed half – moving half – impression – cavity – core – ejector grid. Metal flow systems in die casting die – Machine suitability – the goose neck – the nozzle – the sprue – runner systems – shock absorber – gate – air vents – over flows.

07Hrs

Module 4

Defects and remedies of die casting- Cold type defects – reasons for the occurrence of two type's cold defects- remedies for avoiding. Hot type defects – reasons for the occurrence of five type's hot defects on a die cast component.

– Remedies for avoiding. Miscellaneous defect – suggesting reasons and remedies for the six types of defects on the die cast component. **07Hrs**

Module 5

Plastic Product design guide line and injection moulding of metals - Selection of product market need – prototype – confirm specification – consolidate design –manufacturing stage – quality parameters – validate the outcome – launch product. Introduction of MIM. MIM process. Applications of MIM parts.

07Hrs

Module 6

Advancement in Other Processing Technique- New techniques like Resin transfer molding, Pultrusion. Filament winding, multi-layer rotation molding, Centrifugal casting.

06Hrs

Text Books

1. Introduction of injection mould design -Pye
2. All about Plastics -NI George
3. Injection molding, Theory and practice -Irvin I Rubin

Reference Books:

1. Die Moulds and Jigs -V. Vladimir
2. Plastic material & Process- Schwartz

Course code: 17VT603 Total Hours: 30 hrs	ESTIMATION & COSTING	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to enable students : 1. Highlight the importance of Estimation**.** 2. Highlight the importance of costing and constituents of estimate. 3. Determine the selling price of a component. 4. Familiarizing with all the steps in finding the basic machine hour rate. 5. Highlight the methods of estimating the tooling. 6. Familiarization of estimation guide. 7. Familiarize with the standard estimation sheet for the press tools 8. Work out estimates for jigs, fixtures, moulds and dies. 9. Work out cost of components.				
Course Outcomes	Students after the completion of this course will be able to : 1. Understand the importance of Estimation and costing. 2. Apply the concept of selling price of a component. 3. Work out estimates for jigs, fixtures, moulds, dies and cost of components.				

Module 1

Importance of estimation and costing- Estimation – meaning-define, aims of estimating. Over and under estimation. Quality of an estimator. Source of errors in estimation. Meaning of costing. Aims of costing. Constituents of estimates: design time- drafting time- planning and production design and arrangements of special items- experimental work- material, labor – overheads. Time allowances: set up time- operation time- tear down time-miscellaneous allowances.

06Hrs

Module 2

Selling price of a component and basic machine hour rate- Elements of cost: direct material-indirect materials- direct labor- indirect labor-direct expense- indirect expense. Components of cost: prime cost- factory cost- office cost- total cost- selling price. Numerical problems. Factors in finding basic machine hour rate- capital cost- depreciation- interest on capital cost- energy cost- space cost- maintenance and servicing cost- scrap value. Numerical calculations.

06Hrs

Module 3

Methods of estimating the tool and estimation guide- Rough method of estimation- advantages and disadvantages. Estimation guide for press tool: time for round punches-blanking in single stage- embossing in single stage- round holes in progressive tools- notching in progressive tools- bending in progressive tool.

06Hrs

Module 4

Standard estimation sheet for press tools, moulds and dies- Standard estimation sheet: basic die- basic tool-extra allowance-raw material cost- die set cost- design charges. Estimation of press tool: use of standard estimation sheet- arrive at a final cost- work out. Estimation for one jig and a Fixture. Injection mould estimate: simple single cavity injection

mould- multi cavity injection mould- injection mould with side core. Compression mould estimation: single cavity – multi cavity. Transfer mould estimation. Pressure die casting estimation.

07Hrs

Module 5

Cost of component- Sheet metal: raw (weight norm) material cost- labor cost – amortization cost- extra expenses. Molded components: Raw material cost- shot weight (including runner and sprue) - labor cost- extra expenses. Machined and casted component.

05Hrs

Text books

1. Mechanical estimation and costing - T.R. Banga & S.C. Sharma
2. Principles and practices of Book - V.A.Patil & Keeping J.S. Korlahalli

Reference books:

1. Rahman's Cost and Management Accounting.
2. Nafees baig Problems of Management accounting.

Course code: 17VT604 Total Hours: 30 hrs	INDUSTRIAL MANAGEMENT	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to make the students 1. To know the definitions and levels of management. 2. To understand the meaning of productivity. 3. To study the importance of quality circle. 4. To highlight the modern production management system. 5. To know the definition of TQM/TPM. 6. To understand the industrial & factories act.				
Course Outcomes	Upon successful completion of this course, the trainee will be able to: 1. Explain the importance of quality circle and productivity. 2. Analyze the levels of management and TQM/TPM. 3. Explain the concept of industrial & factories act				

Module 1

Evolution and nature of management, inspection and quality control- Management Process and Functions. Levels of management, role and responsibility. Business Organizations & Plant Layout. Quality control-inspection. 7 QC tools. SQC and SPC. Quality circles Definition and origin. Structure and operation. Quality standards. QS 9000 Quality Standards. ISO 9000 Clauses. Steps to Implement. **06Hrs**

Module 2

Environmental pollution and industrial safety- Air, Water, Solid, Noise Pollution and Control Methods. Environment Management System - ISO 14001. Losses due to Industrial Accidents. Direct & Indirect Losses. Preventive Measures. Safety Committee & Safety Management System (OSHAS 18001).

06Hrs

Module 3

Modern production management system and TQM / TPM- 5S. KAIZEN. KANNBAN. POKA – YOKE. TQM-overview. TQM contribution of quality gurus. Control-Steps to implement TQM. TPM-importance and implementation. Production and productivity. **06Hrs**

Module 4

Estimation and costing, human resources and management- Importance of estimation and costing. Sources of errors. Costing definition and importance. Estimation of cost. Components of cost. Estimation methods of complete projects-case studies. Recruitment Procedure. Training &Training Needs. Leadership. Team Building & Creativity

06Hrs

Module 5

Industrial relations and legislations- employee's welfare facilities. Industrial relations-industrial disputes. Trade union act-rights and liabilities. Indian factories act. Payment of wages act. Workmen's compensation act. Esi, pf act.

06Hrs

Text Books

1. Industrial Engineering and Management - O P Khanna.

Reference Books

1. Hi tech industrial management - B C Prabhakar.

Course code: 17VT606 Total Hours: 90 hrs	TOOL DESIGN DRAWING-IV	L	T	P	C
			-	-	6
Course Objectives	The objective of this course is to make the students understand : 1. Training in the ability to design a Compression mold. 2. Training in the ability to design a Transfer mold. 3. Training in the ability to design a Multi stage mold with positive pull mechanism. 4. Training in the ability to design a Die casting Die. 5. Training in the ability to design multi-function Progressive Tool.				
Course Outcomes	After successful completion of the course, the students should be able to : 1. Design all the elements of compression mold and transfer mold. 2. Design a die casting die and multi-function Progressive Tool.				

LIST OF EXPERIMENTS

1. **Design of compression mold**- Design of compression mold showing horizontal flash. design of compression mold showing vertical flash.

2. **Design of Transfer mold**- Design of a plunger transfer mold. Design of a pot transfer mold.

3. **Design of a Multi-Day Light mold**- Design of a triple day light.

4. **Design of Die casting die**- Design of a die casting die for a cold chamber system. Design of a die casting die for a hot chamber system.

5. **Design of an Advanced Multi stage Tool**- Design of a progressive tool with multiple operation- cutting, bending, and side cam piercing and parting.

Course code: 17VT607 Total Hours: 60 hrs	WORKSHOP-VI	L	T	P	C
			-	-	4
Course Objectives	The objective of this course is to enable students : 1. Understanding the concepts of different operations such as Bench work, milling and Turning. 2. Understanding the concepts of different operations such as surface grinding and cylindrical grinding.				
Course Outcomes	Students after the completion of this course will be able to: 1. Work independently on different operations such as Bench work, milling, Turning, surface grinding and cylindrical grinding.				

LIST OF EXPERIMENTS

1. **Manufacturing of elements of DIE SET WITH SPIGOT PILLARS -** Top Plate, Cavity plate, guide pillar.
2. **Manufacturing of elements of DIE SET WITH SPIGOT PILLARS -** Bottom plate, core plate, actuating rod.
3. **Manufacturing of elements of DIE SET WITH SPIGOT PILLARS –** stripper plate, core and assembly.

<table>
<tr><td rowspan="5">Course code: 17VT608
Total Hours: 60 hrs</td><td rowspan="5">Project work-II</td><td>L</td><td>T</td><td>P</td><td>C</td></tr>
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<tr><td></td></tr>
<tr><td>Course Objectives</td><td colspan="5">Solve problems related to industry and current research.</td></tr>
<tr><td>Course Outcomes</td><td colspan="5">Solve problems related to industry and current research.</td></tr>
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PROJECT WORK

Solve problems related to industry and current research.

Course code: 17VT611 Total Hours: 30 hrs	LEAN MANUFACTURING SYSTEMS	L	T	P	C
			-	-	2
Course Objectives	The objective of this course is to make the students The students shall be able to: 1. Understand the practices of lean manufacturing in Toyota production system. 2. Analyze the various processes in organizations. 3. Develop lean manufacturing strategies for improving various processes. 4. Implement lean manufacturing principles in different organizations.				
Course Outcomes	Upon successful completion of this course, the trainee will be able to: 1. Understand the concepts of lean manufacturing 2. Implement and analyze lean manufacturing principles				

Module 1

Introduction to Lean Manufacturing: Definition of Lean, Lean and Just-in-Time, Seven major types of non-value-adding wastes in manufacturing processes-Overproduction, queues, transportation, inventory, motion, over processing and defective product.

06Hrs

Module 2

Toyota Production System (TPS): Origins, Underlying principles to TPS-Customer-supplier connection-product and service flows, results of Toyota Production System , Timeline.

06Hrs

Module 3

Key Lean Manufacturing Techniques: 5S-examples-benefits and drawbacks, Single Minute Exchange of Dies(SMED)- examples and benefits, Kanban- examples and benefits, Cellular Manufacturing- examples and benefits.

06Hrs

Module 4

Inventory and Variation: Background, Need of the Inventory, disadvantages of Inventory, Make-to-Stock versus Make-to-Order Production Systems, The Philosophy
and Objectives, Foundation of Quality Control, Quantity Control case study. **06Hrs**

Module 5

Planning and Goals: Hoshin–Kanri Planning, importance of Goals and Goal Deployment, Policy Deployment, Leadership in Goal Development and Deployment

Sustaining the Gains: Importance of Sustaining the Gains, existence of Process gains and loss.

06Hrs

Reference Books:

1. Lonnie Wilson, "How to Implement Lean Manufacturing", McGraw-Hill, 2009 Edition, ISBN: 978-0-07-162508-1,
2. Michael Hammer & James Champy, "Reengineering the Corporation, A Manifesto for Business Revolution", Harper Business Essentials, 2006 Edition, ISBN-978-0060559533
3. Jeffrey K. Liker, "The Toyota Way", The McGraw-Hill, 1st Edition, 2004, ISBN-13: 978- 0070587472.

4. M.G. Korgaonker, "Just In Time Manufacturing", Macmillan India Ltd., 2006 Edition, ISBN: 0333 926633.

Course: Product Development

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**Product Development (Theory & Practice)**
Course Code	**20MDE5033**
Semester	**I Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
4	**2**	**-**	**2**	**6**

Total Semester hours: 6x14= 84 Hours

Theory Component	**2x14**	**28 Hours**
Lab Component	**2x14**	**28 Hours**
Open-ended Project (With Industrial Collaboration based on relevance)	**2x14**	**28 Hours**
	Total	**84 Hours**

Mentoring Hours:

Conduction of Classes: **As per Time Table**

2. Course Details

2.1 Course Aim and Summary

This course is intended to prepare students to design& develop products based on product principles, guidelines and skills. Students will be given experience of developing products through case studies in the lab. At the end of the module students will communicate design concepts through sketches, virtual and physical appearance model.

The course mainly focuses on Product design and development, product planning & specifications, concept generation, selection and testing, product architecture & development economics and rapid prototyping.

2.2 Course Objectives

Theory Component:

The objectives of the Course are to:

- Identify the customer needs, formulate the specifications and carry out need analysis.
- Generate, screen and test the concepts.
- Model the prototypes and carry out economic analysis
- Explain the steps involved in product development process
- Apply various methods for stimulating innovation of a product
- Synthesize design with analysis to develop new product
- Implement product principles in different organizations
- Identify the design factors and processes as per customer specifications.

- Provide a fundamental understanding of common principles, various standards & protocols

Laboratory Component:

The student will be able to

- Be able to explain the steps involved in product development process
- Understand the importance of product development
- Learn project and roles
- Illustrate product design concepts

2.3 Course Outcomes

After undergoing this course students will be able to:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Develop models by applying the concepts of product design theory	**06**
CO2	Solve problems independently and identification of customer needs for the product growth	**03**
CO3	Understand the process of product planning and specifications	**02**
CO4	Have a basic knowledge of concept generation, selection and testing	**01**
CO5	Identify the significance of product architecture and development economics	**04**
CO6	Apply embodiment principles in prototyping for small product business	**03**
CO7	Understand the product development by making a product and evaluate the salient features	**05**

2.4 Course Content

Theory Component:

Unit-1	**Introduction**	05 Hours
	Product development- Characteristics of successful product development, Design and development of products, challenges of product development. A generic development process, front-end process. Identifying Customer Needs- Gather raw data from customers, interpret raw data in terms of customer needs, organize the needs into a hierarchy, establish the relative importance of the needs and reflect on the results and the process.	
Unit-2	**Product Planning & Specifications**	06 Hours
	The product planning process- identify opportunities, Evaluate and prioritize projects, allocate resources and plan timing, complete pre project planning, reflect all the results and the process. Product Specifications- What are specifications, when are specifications established, establishing target specifications, setting the final specifications.	

Unit-3	**Concept Generation, selection and testing**	06 Hours
	Concept generation -clarify the problem, search externally & internally, explore systematically, reflect on the results and the process. Concept Selection- Overview of methodology, concept screening, and scoring. Concept Testing- purpose of concept test, choose a survey population & format, communicate the concept, measure customer response, interpret the result, reflect on the results and the process.	
Unit-4	**Product Architecture & Development Economics**	06 Hours
	Product architecture- implications & establishing the architecture, variety and supply chain considerations, platform planning and related system level design issues. Product Development Economics- Elements of economic analysis, Sensitive analysis, project trade-offs, influence of qualitative factors on project success, qualitative analysis.	
Unit-5	**Prototyping**	05 Hours
	Prototyping basics, principles of prototyping, technologies, planning for prototypes.	
	Total =	**28 Hours**

Laboratory Component:

Experiment 1	Draw complex geometries of conceptual product components in sketch mode	06 Hours
Experiment 2	Working with advanced modeling tools	06 Hours
Experiment 3	Assembly modelling	08 Hours
Experiment 4	Practice methods and techniques of prototype making using sheet metal fabrication	08 Hours
	Open-ended Project (With Industrial Collaboration based on relevance)	28 Hours
	Total	**56 Hours**

2.5 Text Book and References

Text Books:

1. Karl.T.Ulrich and Steven D Eppinger, Product Design and Development- Irwin/McGrawHill - 2000.
2. Geoffery Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacture and Assembly - 2002

Reference Books:

1. Chitale, A. C. and Gupta, R. C., Product Design and Manufacturing, PH1, 3rd Edition, 2003.
2. Tim Jones and Butterworth Heinmann, New Product Development, Oxford, UCI,1997

Course: Additive Manufacturing

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**Additive Manufacturing**
Course Code	**20MDE5045**
Semester	**II Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
4	**2**	**-**	**2**	**6**

Total Semester hours: 6x14= 84 Hours

Theory Component	2x14	28 Hours
Lab Component	2x14	28 Hours
Open-ended Project(With Industrial Collaboration based on relevance)	2x14	28 Hours
	Total	**84 Hours**

Mentoring Hours:

Conduction of Classes: **As per Time Table**

2. Course Details

2.1 Course Aim and Summary

This course is intended to acquaint students with the concept of Additive Manufacturing (AM), various AM technologies, selection of materials for AM, pre and post processingof AM processes, and their applications in various fields.Students will be given experience of developing products through case studies in the lab. At the end of the module students will communicate concepts by virtual and physical appearance model.

2.2 Course Objectives

The objectives of the Course are to:

- Understand importance of additive manufacturing in advance manufacturing process.
- Explore the potential of additive manufacturing in different industrial sectors
- Apply 3D printing technology for additive manufacturing
- Acquire knowledge, techniques and skills to select relevant additive manufacturing process
- Familiarize with various materials that are used in additive manufacturing
- Know the principles, methods, possibilities and limitations of additive manufacturing process

Laboratory Component

The student will be able to

- Optimize the process parameters of FDM machine to improve the quality of the parts produced.
- Build engineering assemblies in plastic material with less process planning.
- Be able to explain the steps involved in Additive manufacturing process

2.3 Course Outcomes

After undergoing this course students will be able to:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Define the various process & materials used in Additive Manufacturing	**01**
CO2	Identify, analyse and solve problems related to Additive Manufacturing processes.	**02**
CO3	Apply technique of CAD and reverse engineering for geometry transformation in Additive Manufacturing	**03**
CO4	Analyse and select suitable process to carry out improvement in Additive Manufacturing	**04**
CO5	Apply knowledge of Rapid tooling in additive manufacturing for various applications	**03**
CO6	Design and fabricate working models for the conceptual applications.	**06**

2.4 Course Content

Theory Component:

Unit-1	**Introduction**	04 Hours
	Overview, history, Basic principle, advantages of additive manufacturing, Procedure of product development in additive manufacturing, Classification, Materials used and challenges in Additive Manufacturing, Tooling, Applications	
Unit-2	**Additive Manufacturing Processes**	07 Hours
	Stereolithography apparatus (SLA), Fused deposition modeling (FDM), Laminated Object Manufacturing (LOM), Selective deposition lamination (SDL), Ultrasonic consolidation, Selective laser sintering (SLS), Laser engineered net shaping (LENS), Electron beam free form fabrication (EBFFF), Electron beam melting (EBM), Plasma transferred arc additive manufacturing (PTAAM), Tungsten inert gas additive manufacturing (TIGAM), Metal inert gas additive manufacturing (MIGAM), Micro- and nano-additive	
Unit-3	**Pre-Processing in Additive Manufacturing**	06 Hours
	Preparation of 3D-CAD model, Reverse engineering, Reconstruction of 3D-CAD model using reverse engineering, Part orientation and support generation,	

	Transformations, STL Conversion, STL error diagnostics, Slicing and Generation of codes for tool path, Surface preparation of materials, pre heating of powders.	
Unit-4	**Post-Processing in Additive Manufacturing**	05 Hours
	Post-processing equipments, support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques	
Unit-5	**Rapid Tooling**	06 Hours
	Introduction to Rapid tooling, classification, Direct and Indirect rapid tooling methods, Applications of additive manufacturing in rapid prototyping & rapid manufacturing, repairing and coating. Process optimization factors influencing accuracy, data preparationerrors,Partbuildingerrors,Errorinfinishing &influenceofbuildorientation.	
Total =		**28 Hours**

Laboratory Component:

Experiment 1	Review of CAD Modeling Techniques and Introduction to Rapid Prototyping	02 Hours
Experiment 2	Generating STL files from the CAD Models & Working on STL files	02 Hours
Experiment 3	Modeling & Assembly in Creative Designs in CAD Software	08 Hours
Experiment 4	Processing the CAD data in Catalyst software (Selection of Orientation, Supports generation, Slicing, Tool path generation)	06 Hours
Experiment 5	Fabricating the physical part on FDM- RP machine	08 Hours
Experiment 6	Demonstrating Creative Working Models	02 hours
	Open-ended Project(With Industrial Collaboration based on relevance)	28 Hours
		56 Hours

2.5 Text Book and References

Text Books:

1. Chee Kai Chua, Kah Fai Leong, 3D Printing and Additive Manufacturing: Principles and Applications: Fourth Edition of Rapid Prototyping, World Scientific Publishers, 2014
2. Ian Gibson, David W. Rosen, Brent Stucker, Additive manufacturing technologies: rapid prototyping to direct digital manufacturing Springer, 2010.
3. Andreas Gebhardt, Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing, Hanser Publishers, 2011.

Reference Books:

1. Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications: A tool box for prototype development", CRC Press, 2007
2. Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006
3. Mahamood R.M., Laser Metal Deposition Process of Metals, Alloys, and Composite Materials, Engineering Materials and Processes, Springer International Publishing AG 2018

Course: MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**MICRO ELECTRO MECHANICAL SYSTEMS (MEMS)**
Course Code	**20MDE5048**
Semester	**II Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
4	**2**	**-**	**2**	**6**

Total Semester hours: 6x14= 84 Hours

Theory Component	2x14	28 Hours
Lab Component	2x14	28 Hours
Open-ended Project(With Industrial Collaboration based on relevance)	2x14	28 Hours
	Total	**84 Hours**

Mentoring Hours:
Conduction of Classes: **As per Time Table**

2. Course Details

2.1 Course Aim and Summary

The course will equip students with the necessary knowledge to use principles of physics to analyze and design MEMS, including sensors and actuators. The students will be exposed to various fabrication and characterization techniques to produce good quality MEMS devices. Students will also gain hands-on experience in using finite element analysis software ANSYS to design MEMS devices.

2.2 Course Objectives

The objectives of the Course are:

- To learn dynamics and modelling of micro-systems
- Understanding design and analysis of micro and Nano system applications
- Develop experience on microsystems for sensors and actuators applications
- To learn and characterize technology for MEMS

- Gain knowledge and have knowledge on state-of-the-art MEMS techniques for Microsystems
- Have an ability to identify, formulate and solve problems in the field of micro electrical systems.

2.3 Course Outcomes

After undergoing this course students will be able to:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Classify the MEMS devices based on its application.	L2
CO2	Demonstrate the working principles of various mechanical sensors and actuators	L2
CO3	Apply the concept of microfluidics in various applications	L3
CO4	Design the various mechanical sensors and actuators	L4
CO5	Identify the suitable fabrication method for a MEMS device	L3
CO6	Choose the appropriate characterization techniques to characterize the MEMS systems.	L3

2.4 Course Content

Theory Component:

Unit-1	**Introduction**	06 Hours
	Micro Electro-Mechanical Systems, Ultra Precision Engineering, Microsensors; Micro-actuators; Microelectronics Fabrication; Micromachining; Mechanical MEMS; Thermal MEMS : MOEMS; Magnetic MEMS; RF MEMS; Micro-fluidic Systems; Bio and Chemo – Devices; MEMS Packages and Design Considerations; MicroInstrumentation.	
Unit-2	**Mechanical Sensors and Actuators**	06 Hours
	Principles of Sensing and Actuation; Beam and Cantilever; Micro plates; Capacitive Effects; Piezoelectric material as Sensing and Actuating Elements; Strain Measurement; Pressure measurement; Flow Measurement using Integrated Paddle – Cantilever Structure; Pressure Measurement by Microphone; Shear mode Piezo actuator; Gripping Piezo actuator; Inchworm Technology.	
Unit-3	**Thermal and Fluidic Micro Sensors and Actuators**	06 Hours
	Thermal sensors, Electrical Sensors, Chemical and Biosensors Electromagnetic and Thermal micro actuation, Mechanical design of micro actuators, examples, Micro Fluidic systems, Fluid actuation methods, micro valves, micro pumps, micro motors-Micro actuator systems : Ink-Jet printer heads, Micro-mirror TV Projector.	
Unit-4	**MEMS- Design and Analysis**	05 Hours
	Basic concepts of design of MEMS devices and processes, Design for fabrication, Other design considerations, Analysis of MEMS devices, FEM and Multiphysics analysis, Modelling and simulation.	

Unit-5	**MEMS- Characterization**	05 Hours
	Technologies for MEMS characterization, Scanning Probe Microscopy (SPM): Atomic Force Microscopy (AFM), Scanning tunnelling microscopy (STM), Magnetic Force Microscopy, Scanning Electron Microscope, Laser Doppler vibrometer, Electronic Speckle Interference Pattern technology (ESPI)	
Total =		**28 Hours**

Laboratory Component:

Experiment 1	Analysis of the optimal dimension on the electrothermal microactuator, MEMS accelerometer and gyroscopes	6 Hours
Experiment 2	Paper based MEMS devices – Design and fabrication	8 Hours
Experiment 3	Simulation – Fabrication of MEMS devices	6 Hours
Experiment 4	Application projects of MEMS devices – using IMU	8 Hours
	Open-ended Project (With Industrial Collaboration based on relevance)	28 Hours
		56 Hours

2.5 Text Book and References

Text Books:

1. Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning Private Limited, 2009.
2. Stephen D. Senturia, Microsystem Design, Springer, 2001
3. Marc Madou, Fundamentals of Microfabrication, Taylor & Francis Group, 2002
4. Gregory Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998

Reference Books:

1. Bao, M.H., Micromechanical Transducers- Pressure sensors, accelerometers, and gyroscopes, Handbook, Elsevier, 2000.
2. Nadim Maluf, An Introduction to Micro electromechanical Systems Engineering, Artech House Publishers, 2000.
3. Stephen D. Senturia, Microsystems Design, Kluwer Academic Publishers, New York, November 2000

Course: Finite Element Method

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**Finite Element Method**
Course Code	**20MDE5102**
Semester	**I Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
5	**3**	**-**	**2**	**7**

Total Semester hours: 7x14= 98 Hours

Theory Component	3x14	42 Hours
Lab Component	2x14	28 Hours
Open-ended Project(With Industrial Collaboration based on relevance)	2x14	28 Hours
	Total	**98 Hours**

Mentoring Hours:

Conduction of Classes: **As per Time Table**

2. Course Details

2.1 Course Aim and Summary

The course will equip students with the necessary knowledge to use finite element analysis to solve problems related to statics, dynamics, and heat-transfer. FEA is a design/research tool that is extensively used in industry and research institutions. Students will also gain hands-on experience in using finite element analysis software ANSYS to solve realistic engineering problems.

2.2 Course Objectives

The objectives of the Course are:

- Introduce the various aspects of FEM as applied to engineering problems.
- Define the element properties such as shape function and stiffness matrix for the various elements
- Formulate element properties for 1D, 2D elements
- Use of FE tool in linear structural, heat transfer, and dynamics problems
- Analyze bars and trusses
- Analyze plane elasticity problems
- Formulate and solve dynamic problems

Laboratory Component

- Understand and formulate the problem based on given geometry and physics
- Know how to model, analyze mechanical systems using finite element analysis software
- To impart knowledge for creating 1D/2D/3D models using preprocessing of FE software
- To impart knowledge for creating 2D/3D models using CAD software and export to finite element software
- Learn the use of commercial software to solve complex problems

2.3 Course Outcomes

After undergoing this course students will be able to:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Apply the weighted residual method and Rayleigh-Ritz method to approximate the solutions of simple problems	L3
CO2	Develop finite element formulations for bar and beam elements using linear and quadratic shape functions and use them in simple heat transfer problems	L3
CO3	Formulate and use iso-parametric, axisymmetric, serendipity elements and use natural co-ordinate systems	L3
CO4	Demonstrate the applications to solid mechanics problems and dynamic considerations	L3
CO5	Model and analyze mechanical systems using ANSYS software	L5

2.4 Course Content

Theory Component:

Unit-1	**Introduction to the Finite Element Method**	08 Hours
	Introduction, Engineering Analysis, Convergence criteria, Vibrational formulations, weighted residual methods, Potential Energy 1D Bar Element, Admissible displacement function, Strain matrix, Element equations, Stiffness matrix, Consistent nodal force vector: Body force, Initial strain.	
Unit-2	**One-Dimensional Elements**	08 Hours
	Analysis of Bars and Trusses, Basic Equations and Potential Energy Functional, 1-D Bar Element, Assembly Procedure, Boundary and Constraint Conditions, 2-D Bar Element, 3-D Bar Element, Beam Element, Hermite shape functions, 1D Heat transfer, Truss element, Test Problems and Applications.	
Unit-3	**Two-Dimensional Elements**	10 Hours
	Analysis of Plane Elasticity Problems, Three- Noded Triangular Element (TRIA 3), Four- Noded Quadrilateral Element (QUAD 4), Axisymmetric Solid Elements: Geometric representation, Admissible displacement functions, Element stain matrix, Element stiffness matrix, Consistent nodal force vector: Body force, initial strain, Importance of higher order elements, Practical Applications.	

Unit-4	**Three-Dimensional Elements**	08 Hours
	Applications to Solid Mechanics Problems: Basic Equations and Potential Energy Functional, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Serendipity family, Lagrange family, Shape functions for Higher Order Elements.	
Unit-5	**Dynamic Considerations**	08 Hours
	Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, beam element. Lumped mass matrix, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.	
	Total =	**42 Hours**

Laboratory Component:

Experiment 1 (Revision)	1-D Elements, Bar, Truss & Beam Elements, Static & Dynamic Analysis	04 Hours
Experiment 2	Geometric Modeling of 2-D geometry using Ansys, Import 2-D geometry from other Modeling software 2-D Elements, Triangular & Quadrilateral, Liner and Higher-Order elements, Meshing Techniques; Manual & Automatic Meshing in Ansys,	06 Hours
Experiment 3	Geometric Modeling of 3-D geometry using Ansys, Import 3-D geometry from other Modeling software 3-D Elements, Tetrahedral & Hexahedral, Liner and Higher-Order elements, Meshing Techniques in 3-D; Manual & Automatic Meshing in Ansys, Import mesh from Hypermesh,	6 Hours
Experiment 4	Analysis of Structures 2-D & 3-D: Static Analysis. Modal Analysis. Harmonic Analysis. Spectrum Analysis. Buckling Analysis, Analysis of Composites.	6 Hours
Additional Learning	Students are trained in 3D Modeling such as Fusion 360 & CATIA	6 Hours
	Open-ended Project (With Industrial Collaboration based on relevance)	28 Hours
		56 Hours

2.5 Text Book and References

Text Books:

1. Rao S. S., Finite Elements Method in Engineering, 4th Edition, Elsevier, 2006.
2. Chandrupatla T. R., Finite Elements in Engineering, 2nd Edition, PHI, 2007.
3. Lakshminarayana H. V., Finite Elements Analysis, Procedures in Engineering, Universities Press, 2004.

Course: SOLID MECHANICS

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**SOLID MECHANICS**
Course Code	**20MDE5103**
Semester	**I Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
5	**3**	**-**	**1**	**5**

Total Semester hours: 7x14= 98 Hours

Theory Component	3x14	42 Hours
Lab Component	2x14	28 Hours
Open-ended Project(With Industrial Collaboration based on relevance)	2x14	28 Hours
	Total	**98 Hours**

Mentoring Hours:

Conduction of Classes: **As per Time Table**

2. Course Details

2.1 Course Aim and Summary

To ascertain whether an assumption of plane stress / plane strain / axisymmetric is valid for a given state of loading

To design and analyze structures using hand calculations (wherever possible) or by using a general purpose FEA software

2.2 Course Objectives

The objectives of the Course are:

- To able to assess the stress/deformations for a given case of loading
- To apply the yield criteria to assess whether the material has undergone yielding
- To understand asymmetrical bending and the influence of shear Centre
- To analyze beams of different cross sections for bending
- To analyze bars of various cross sections for torsion
- To understand the procedure for axisymmetric and thermal stress analysis
- Demonstrate the ability to use commercial software to solve simple and complex structural problems.

Laboratory Component

The student will be able to

- To know how to model mechanical systems using finite element analysis software and analyse structural response.
- Tosimplify structural problems and analyse using finite element software such as through plane stress/plane strain/ axisymmetric assumptions.

2.3 Course Outcomes

After undergoing this course students will be able to:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To identify & analyse plane stress / plane strain / axisymmetric problems	L1/L2/L3
CO2	To analyse the principal stresses principal strain and principal planes for generalised case of loading in an isotropic material	L3
CO3	To assess the plastic deformation using different yield criterions	L2
CO4	To identify the shear centre of a beam section	L2
CO5	To analyse the structure subjecting to bending or torsion	L4
CO6	Design and analyse structures using hand calculation or using FEA	L5

2.4 Course Content

Theory Component:

Unit-1	**Analysis of Stress**	08 Hours
	Introduction, The State of Stress at a point, Stress Components on an Arbitrary Plane, Principal Stresses, Stress Invariants, Mohr's Circles for the Three-Dimensional State of Stress, Mohr's Stress Plane, Planes of maximum shear, Octahedral Stresses, State of pure shear, Decomposition into hydrostatic and pure shear states, Cauchy's stress quadric, Lame's Ellipsoid, The plane state of stress, Differential equations of equilibrium, Equations of equilibrium for Plane Stress State, Equations of equilibrium in cylindrical coordinates, axisymmetric stress state	
Unit-2	**Analysis of Strain**	06 Hours
	Introduction, Deformations, Change in length of a linear element, The state of strain at a point, Principal axes of strain and principal strains, Plane state of strain, Plane strain in polar coordinates, Compatibility conditions, Strain Deviator and its invariants	
Unit-3	**Stress-strain relations for linearly elastic solids, theories of failure and introduction to ideally plastic solid, Thermal stresses**	10 Hours
	Generalized statement of Hooke's law, Displacement Equations of Equilibrium, Theories of failure, Ideally Plastic Solid, Stress space and strain space – Deviatoric	

	plane or π-plane, Yield Surfaces of Tresca and Von-Mises, Stress-strain relationship (Plastic flow), Prandtl-Reuss Equations Thermal stresses-Thermoelastic stress strain relations, Equations of equilibrium, strain-displacement relations, general problems	
Unit-4	**Bending of Beams**	08 Hours
	Straight beams and Asymmetrical Bending, Euler-Bernoulli Hypothesis, Shear centre or centre of flexure, shear stresses in a thin-walled open sections, shear centre of T or L sections, Bending of curved Beams	
Unit-5	**Torsion, and Axisymmetric problems**	08 Hours
	Torsion of general prismatic bars (Circular/Elliptical/Equilateral Triangular/Rectangular), Membrane Analogy, Torsion of thin walled tubes, Torsion of bars with thin rectangular sections, Centre of twist and flexural centre. Axisymmetric problems: Lame's problem, Stresses in composite tubes-shrink fit, Rotating discs of uniform thickness, Discs of variable thickness, Rotating shafts and cylinders	
	Total =	**42 Hours**

Laboratory Component:

Experiment 1	Identification of principal stresses and principal planes using MATLAB	4 hours
Experiment 2	Evaluation of normal stresses in straight beams as a result of thermal loading through MATLAB/FEA.	4 hours
Experiment 3	Comparison of axisymmetric analysis with Full 3D modelling using FEA.	6 hours
Experiment 4	Analysis of beams when it is subject to symmetrical / asymmetrical bending using FEA	4 hours
Experiment 5	Analysis of Torsion of bars of various cross section using FEA	4 hours
Experiment 6	Analysis a typical connecting rod or a pressure vessel using FEA	6 Hours
	Open-ended Project (With Industrial Collaboration based on relevance)	28 Hours
		56 Hours

2.5 Text Book and References

Text Books:

1. Srinath , L. S. Advanced Mechanics of Solids , Tata McGraw-Hill Education, Third Edition, 2008.
2. Kazimi, S. M. A. Solid Mechanics, Tata McGraw-Hill Education, 2001
3. Allan F. Bower, Applied Mechanics of Solids, CRC Press, 2009

Reference Books:

1. Shames I.H and Pitarresi, J.M.P., Introduction to Solid Mechanics, PHI Publications, Third Edition, 1999.
2. Phillips, Durelli and Tsao, Analysis of Stress and Strain, McGraw Hill Book, 1958.

Course: Advanced Materials and Manufacturing Technology

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech. programme**
Specialization	**Design Engineering**
Course Title	**Advanced Materials and Manufacturing Technology**
Course Code	**20MDE5201**
Semester	**II Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
5	**3**	**-**	**2**	**7**

Total Semester hours: 7x14= 98 Hours

Theory Component	3x14	42 Hours
Lab Component	2x14	28 Hours
Open-ended Project(With Industrial Collaboration based on relevance)	2x14	28 Hours
	Total	**98 Hours**

Mentoring Hours:

Conduction of Classes: **As per Time Table**

2. Course Details

2.1 Course Aim and Summary

The main aim of the course is to prepare the students to gain knowledge in the advanced materials and latest manufacturing process to recommend the feasibility, utilization of the materials that can be adopted in industries.The course involves new technology related to materials applications research, with focus on advanced device design, fabrication and integration, as well as new technologies based on novel materials.

2.2 Course Objectives

Theory Component:

- To study the behavior of various materials with different structure-property relationship
- To introduce the various aspects Ceramics, composites, MMCS
- To learn fabrication and operational skills and applications for Composite materials
- To have overview of surface engineering and other treatments for materials environment.

Laboratory Component:

- To understand the preparation of polymer composites through hand lay-up, vacuum bagging and resin transfer moulding process.
- To comprehend the 3D printing of polymer/metal/ceramic samples.

- To design new materials using ANSYS Material Designer.
- To perform mould flow analysis
- To work on open ended problems/projects related to advanced materials.

2.3 Course Outcomes

After undergoing this course students will be able to:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	**Understand** the properties of materials and its structure-property relationship	L2
CO2	**Understand** the principles underlying the functional and mechanical behaviour of ceramic materials	L2
CO3	**Develop** competency in composite manufacturing techniques, and be able to select the appropriate technique for manufacture of various composite products.	L3
CO4	**Analyse** real life surface failure problems and determine the correct surface engineering solution.	L4
CO5	**Create** a Representative Volume Elementsand compute the responses while exposing it to several macroscopic load cases.	L3
CO6	**Prepare**a new composite specimen using advanced materials.	L3

2.4 Course Content

Theory Component:

Unit-1	**Introduction**	10 Hours
	Introduction- Properties of Materials, Structure property relationship, Newer Materials – Ceramics and Composite materials, Ceramics – Fine ceramics, Types of ceramics, Structure of Ceramics, Properties of Ceramics, Applications.	
Unit-2	**Composite Materials**	08 Hours
	Composite Materials- Types – Metal matrix Composites (MMC), Ceramic Matrix Composites (CMC), Polymeric composites Structure, Properties and Applications of different composite materials.	
Unit-3	**Processing of Metal matrix Composites (MMC), Ceramic Matrix Composites (CMC)**	08 Hours
	Processing of MMC & CMC, Vacuum infiltration, squeeze casting, pressure die casting, Rheo-casting, Compo-casting, Super plastic forming	
Unit-4	**Processing of Polymer matrix Composites (PMC)**	08 Hours
	Processing of PMC-Hand Lay Up, Bag Molding Process, Autoclave molding, Compression molding, Pultrusion, Filament winding, Resin Transfer molding, Injection molding.	

Unit-5	**Surface Engineering**	08 Hours
	Surface Engineering- Surface quality & integrity, concepts, Mechanical treatment, Thermal & Thermo-chemical treatment. Thermal Spraying Processes and Applications- Vapor depositions processes and applications, Ion-treatment, Laser Treatment.	
	Total	**42 Hours**

Laboratory Component:

Experiment 1	Preparation of polymer composites through hand lay-up, vacuum bagging and resin transfer moulding process.	7 Hours
Experiment 2	Preparation of polymer/metal/ceramic samples using 3D printing.	7 Hours
Experiment 3	Designing new materials for various applications using ANSYS Material Designer.	7 Hours
Experiment 4	Mould flow analysis using ANSYS	7 Hours
	Open-ended Project (With Industrial Collaboration based on relevance)	28 Hours
	Total	**56 Hours**

2.5 Text Book and References

Text Books:	
1. Paul Degarmo, E. Black, J.T. and Ronald A Kohser, Materials and Processing in Manufacturing, John Wiley & Sons, 2011. 2. Minoru Taya, and Richard J. Arsenault, Metal Matrix Composites, Elsevier Science & Technology, 1989 3. Mallick, P.K. Fiber-Reinforced Composites: Materials, Manufacturing, and Design, Third Edition, CRC Press, 2007	
Reference Books:	
1. Schwartz, M.M. Composite Materials Handbook, Second Edition, McGraw Hill Higher Education, NewYork, 1995 2. Tadeusz Burakowski and Tadeusz Wierzchon, Surface Engineering of Metals: Principles, Equipment, Technologies, CRC Press, 1998	

Course: Mechanics of Composite Materials

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**Mechanics of Composite Materials**
Course Code	**20MDE5202**
Semester	**II Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
5	**3**	**-**	**2**	**7**

Total Semester hours: 7x14= 98 Hours

Theory Component	3x14	42 Hours
Lab Component	2x14	28 Hours
Open-ended Project(With Industrial Collaboration based on relevance)	2x14	28 Hours
	Total	**98 Hours**

Mentoring Hours:

Class Schedule: **As per Time Table**

2. Course Details

2.1 Course Aim and Summary

- Identify the class of composite materials
- Assess the properties of the designed composite laminate based on its configuration
- Design and analyse composite configurations for structural applications

2.2 Course Objectives

The objectives of the course are:

- to tailor a composite to get desired characteristics (such as orthotropy/transverse isotropy/quasi-isotropy)in a composite
- to estimate the lamina properties from the constituents through micromechanical relations
- to evaluate the stresses/strains in a lamina for given case of loading
- to assess whether the lamina has undergone failure for a given state of loading
- to predict the properties of laminate based on the laminate configurations
- to predict the failure of laminate based on failure analysis of lamina
- to assess influence of temperature and humidity on the degradation of properties and failure of laminates

Laboratory Component

The student will be able to

- To use MATLAB to assess the properties of lamina/laminate and use it for design of composite laminates
- Implement failure models (Already available/user defined) in ANSYS to analyse composite structure.

2.3 Course Outcomes

After undergoing this course students will be able to:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	To identify the class of composite materials (isotropic/orthotropy/anisotropy) based on its structure/configuration	L1
CO2	To estimate the properties of lamina from constituents	L2
CO3	To assess the failure of lamina for given loading condition	L3
CO4	To assess the laminate properties for a given stacking sequence	L2
CO5	To analyse the failure of laminate for given case of loading	L4
CO6	To design a composite configuration for any given case of loading taking into account the process/environment induced stresses etc	L5

2.4 Course Content

Theory Component:

Unit-1	**Introduction and Micromechanics of a lamina**	08 Hours
	Introduction to Composite Materials-Definition and Characteristics, Historical Development, Applications, Advantages and Limitations. Structural Performance of Conventional Materials, Geometric and Physical Definitions, Material Response under Load, types and Classifications of composite Materials, Lamina and Laminate , scales of Analysis, Basic lamina properties, Degree of Anisotropy. Micromechanical relationship for evaluation of lamina level properties from the constituents	
Unit-2	**Module II – Macromechanics of a lamina**	08 Hours
	Elastic Behavior of Composite Lamina -Stress- Strain relations, Relations between Mathematical and Engineering Constants, Stress- Strain Relations for a Thin Lamina (2-D), Transformation of stress and stain (2-D, 3-D), Transformation of Elastic Parameters (2-D, 3-D), Transformation of stress and strain relations in terms of Engineering Constants (2 –D), Transformation relations for Engineering Constants (2 – D).	

Unit-3	**Failure theories of an orthotropic lamina**	08 Hours
	Strength of Composite Lamina-Introduction, Failure Theories, Maximum Stress Theory, Maximum Strain Theory, and Energy based Interaction Theory, Interactive Tensor Polynomial Theory, Failure- Mode – Based Theories, Failure Criteria for Textile Composites, Computational Procedure for Determination of Lamina Strength, Evaluation and Application of lamina Failure Theories.	
Unit-4	**Macromechanics of laminates**	10 Hours
	Laminate Terminiologies, Definitions, Elastic behavior of Multidirectional Laminates-Basic Assumptions, Strain – Displacement Relations, Stress- Strain Relations of a Layer within a laminate, Force and Moment Resultants, General Load –Deformation Relations: Laminate Stiffness, Inversion Load –Deformation Relations: Laminate Compliances, symmetric Laminates, Balance Laminates, Orthotropic Laminates, quasi- isotropic Laminates, Laminate Engineering Properties. Computational Procedure for Determination of Engineering Elastic Properties . Failure and Strength prediction of multi-directional laminates	
Unit-5	**Hygrothermal effects on laminates**	08 Hours
	Hygrothermal Effects -Introduction, Hygrothermal Effects on Mechanical Behavior, Coefficient of thermal and Moisture Expansion of a Unidirectional Lamina, Hygrothermal Strains in a Unidirectional lamina, Hygro thermo elastic Load - Deformation and Deformation – Load relations, Hygro thermal Load-Deformation relations, Co-efficient of thermal and Moisture Expansion - Multidirectional Laminates and Balanced/Symmetric laminates. Physical significance of Hygrothermal forces and Moments, Hygrothermal Isotropy and Stability. Coefficient of thermal Expansion of Unidirectional and Multidirectional carbon/ Epoxy Laminates, Hygro thermo elastic stress Analysis of Multidirectional laminates, Residual stresses.	
	Total =	**42 Hours**

Laboratory Component:

Experiment 1	Prediction of offaxis lamina strength using MATLAB	04 Hours
Experiment 2	Prediction of Laminate strength using CLT implemented in MATLAB	08 Hours
Experiment 3	Comparison of blunt notch strength of composite laminates with isotropic plate with a hole using FEA	08 Hours
Experiment 4	Composite plate subjected to plane stress conditions using FEA	08 Hours
	Open-ended Project (With Industrial Collaboration based on relevance)	28 Hours
		56 Hours

2.5 Text Book and References

Text Books:
1. Srinath , L. S. Advanced Mechanics of Solids , Tata McGraw-Hill Education, Third Edition, 2008. 2. Kazimi, S. M. A. Solid Mechanics, Tata McGraw-Hill Education, 2001 3. Allan F. Bower, Applied Mechanics of Solids, CRC Press, 2009
Reference Books:
1. Shames I.H and Pitarresi, J.M.P., Introduction to Solid Mechanics, PHI Publications, Third Edition, 1999. 2. Phillips, Durelli and Tsao, Analysis of Stress and Strain, McGraw Hill Book, 1958.

Course: ADVANCED MACHINE DESIGN

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech**
Specialization	**Design Engineering**
Course Title	**Advanced Machine Design**
Course Code	**20MDE5203**
Semester	**II Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
5	**3**	**-**	**2**	**7**

Total Semester hours: 7x14= 98 Hours

Theory Component	3x14	42 Hours
Lab Component	2x14	28 Hours
Open-ended Project(With Industrial Collaboration based on relevance)	2x14	28 Hours
	Total	**98 Hours**

Mentoring Hours:

Conduction of Classes: **As per Time Table**

2. Course Details

2.1 Course Aim and Summary

The course will equip students with the necessary knowledge of failure prevention analysis in mechanical design, modes of mechanical failure, review of failure theories, stress-life approach, strain-life approach, LEFM approach, fatigue from variable amplitude loading &surface failure.

2.2 Course Objectives

The objectives of the Course are:

1. To review the theory of failures, fatigue, creep, wear of surfaces
2. Understand fatigue crack growth, stress life, and LEFM approach
3. To identify and able to solve engineering design problems
4. To know the basics of surface failure, stress, and strength

Laboratory Component

5. To train commercial FE software to solve fatigue and fracture problems
6. To perform fatigue & fracture failure analysis of structures and components using finite element analysis software

2.3 Course Outcomes

After undergoing this course students will be able to:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Review the theory of failures, fatigue, creep, wear of surfaces	L2
CO2	Understand basic machine elements in machine design and understand their concepts in life estimation	L1
CO3	Explain LEFM concepts and S-N approach for notched members	L1
CO4	Understand the basics of surface failure, stress, and strength	L1
CO5	Demonstrate fatigue failure of mechanical components using ANSYS software	L3
CO6	Analyze fracture failure in different components using ANSYS software	L3

2.4 Course Content

Theory Component:

Unit-1	**Introduction**	10 Hours
	Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples. High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods, and standard test specimens, Fatigue fracture surfaces, and macroscopic features, Fatigue mechanisms, and microscopic features.	
Unit-2	**Stress-Life (S-N) Approach**	08 Hours
	S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behavior, S-N curve representation, and approximations, Constant life diagrams, Fatigue life estimation using S-N approach. Strain-Life (ε-N) approach: Monotonic stress-strain behavior, Strain controlled test methods, Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by ε-N approach.	
Unit-3	**LEFM Approach**	08 Hours
	LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, Notch strain analysis, and the strain – life approach, Neuber's rule, Glinka's rule, applications of fracture mechanics to crack growth at notches.	

Unit-4	**Fatigue from Variable Amplitude Loading**	08 Hours
	Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction, and sequence effects, Cycle counting methods, Life estimation using stress life approach.	
Unit-5	**Surface Failure**	08 Hours
	Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.	
	Total	**42 Hours**

Course Content Lab Component:

Experiment 1	Fatigue analysis in ANSYS | fatigue failure | high cycle & low cycle fatigue life	7 Hours
Experiment 2	Fatigue Analysis of a plate with a hole using ANSYS Workbench	7 Hours
Experiment 3	Fatigue analysis of a formula SAE Hub	7 Hours
Experiment 4	fracture testing using Ansys workbench	7 Hours
	Open-ended Project (With Industrial Collaboration based on relevance)	28 Hours
	Total	**56 Hours**

2.5 Text Book and References

Text Books:	
1. Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens, and Henry O. Fuchs, Metal Fatigue in Engineering, John Wiley, New York, Second edition. 2001. 2. Jack. A. Collins, Failure of Materials in Mechanical Design, John Wiley, New York 1992.	
Reference Books:	
1. S. Suresh, Fatigue of Materials, Second Edition, Cambridge University Press, Cambridge, U.K.1998 2. Julie. A. Benantine, Fundamentals of Metal Fatigue Analysis, Prentice-Hall, 1990 3. ASM Metals Hand Book, Fatigue and Fracture, Vol 19, 2002.	

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19ME3501**					
TITLE OF THE COURSE	**Heat Transfer (Theory & Practice)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**70**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	III	19ME2304	Thermodynamics

COURSE OBJECTIVES :

- To understand the basic phenomenon of heat transfer and its importance in engineering applications.
- To enable the students to understand the different modes of heat transfer like conduction, convection and radiation.
- To understand the mechanism of heat transfer under steady and transient conditions
- To illustrate the applications of convective heat transfer including heat exchangers, boiling & condensation
- To understand the different laws of radiation and applying for solving engineering problems

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Compute temperature distribution and heat flow in steady-state and unsteady-state 1-D heat conduction	L3
CO2	Calculate forced and free convective heat transfer coefficient and rate of heat transfer	L3
CO3	Analyze performance characteristics of heat exchangers	L4
CO4	Calculate radiation heat transfer between objects with simple geometries	L3
CO5	Demonstrate conduction, convection, and radiation heat transfer phenomena through experiments	L2

COURSE CONTENT:	
MODULE 1	**08 Hrs**
Modes of heat transfer: Basic laws governing conduction, Thermal conductivity. Conduction: Derivation of general three dimensional conduction equation in Cartesian coordinate, discussion on 3-D conduction in cylindrical and spherical coordinate system. One dimensional	

conduction equations for plane, cylinder and spheres. Overall heat transfer coefficient, Thermal conductive resistance and numerical problems. Derivation for heat flow and temperature distribution in a plane for variable thermal conductivity case, critical thickness of insulation and numerical problems.
MODULE 2 **08 Hrs**
Introduction, Heat transfer through rectangular fin, infinitely long fin, short fin with insulated tip and without insulated tips. FIN efficiency and effectiveness. Numerical problems. Transient Conduction: Lumped parameter analysis, use of transient temperature charts (Heisler's charts) for transient conduction in slab, long cylinder and sphere, numerical problems
MODULE 3 **10 Hrs**
Natural Convection: Introduction, laminar flow, momentum and energy equations for vertical flat plate, physical significance of Grashoff number, use of correlations for free convection in vertical, horizontal and inclined flat plates, vertical and horizontal cylinders and spheres, numerical problems. Forced Convection: Applications of dimensional analysis for forced convection. Physical significance of Reynolds, Prandtl, Nusselt and Stanton numbers. Use of various correlations for hydro dynamically and thermally developed flows inside a duct, use of correlations for flow over a flat plate, over a cylinder and sphere. Numerical problems.
MODULE 4 **08 Hrs**
Fundamental concepts of radiation, different laws governing radiation heat transfer, Stefan-Boltzman law, Kirchoff's law, Planck's law, Wein's displacement law, Intensity of radiation and Lambert's cosine law, Radiation shape factor, Heat exchange by radiation between two black and diffuse gray surfaces, radiation shields, numerical problems.
MODULE 5 **08 Hrs**
Heat exchangers: Classification and applications, overall heat transfer coefficient, heat exchanger analysis–Logarithmic mean temperature difference for parallel and counter flow heat exchanger, effectiveness–number of transfer units, method for parallel and counter flow heat exchanger, introduction to cross flow heat exchanger, Logarithmic mean temperature difference correction factor. Numerical problems. Condensation and Boiling: Boiling heat transfer, types of boiling, pool boiling curve and forced boiling phenomenon, condensation heat transfer, film wise and drop wise condensation. (no numerical problems).

List of Laboratory/Practical Experiments activities to be conducted (if any) :28Hrs	
1.	Determination of thermal conductivity of metal rod.
2.	Determination of thermal conductivity of composite wall.
3.	Experiment on transient conduction heat transfer.
4.	Determination of heat transfer coefficient in natural convection.
5.	Determination of heat transfer coefficient in forced convection.

6.	Determination of temperature distribution, fin efficiency in natural / forced Convection.
7.	Determination of emissivity of a test surface.
8.	Determination of the emissive power of black body using Stefan's Boltzmann's constant.
9.	Determination of effectiveness and logarithmic mean temperature difference in parallel flow and counter flow heat exchanger.

TEXT BOOKS :

1. Incropera, F.P. and DeWitt, D.P(2011). "Fundamentals of Heat and Mass transfer , John Wiley

REFERENCES :

1. Ozisik(2002.), Heat Transfer-A Basic Approach, Tata Mc Graw Hill.
2. P K Nag (2011), Heat and Mass Transfer, Tata McGrawHill
3. J P Holaman (2009), Heat Transfer, Tata McGrawHill.
4. C.P. Kothandraman, S. Subramanyan(2014), Heat and Mass Transfer Data Book, New Age International Publishers,

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19ME3502**					
TITLE OF THE COURSE	**Kinematics and Theory of Machines**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**1**	**--**	**-**	**56**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To impart knowledge on the kinematics and dynamics of planar mechanisms
- analyze the bodies which is in motion using the basics of kinetics and kinematics
- To determine the balancing of masses of rotating and reciprocating machine elements
- To understand the principles of cams, governors and gyroscope
- To familiarize various mechanism by modeling and simulating the final motion in 3D modeling software
- To be able to make completely balanced systems by identify the angular position and spacing between each masses
- To distinguish the performance of different governors by characterize effort, power and sensitiveness
- To understand the gyroscopic principle and verifying its effect by changing the torque

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Discuss the fundamentals of various mechanisms and its inversion	L2
CO2	Perform velocity and acceleration analysis of a particle in a given system and angular velocity of rigid bodies that are in plane motion.	L3
CO3	Solve the problems related to balancing the parts in rotating and reciprocating systems	L3
CO4	Apply the principles of balancing of masses to various systems and engines	L3
CO5	Construct the cam profile for a desired motion. Recognize the fundamentals of governor and gyroscope	L3

COURSE CONTENT:	
MODULE 1	**12Hrs**
Definitions Link or element, kinematic pairs, chain, Mechanism and Structure, Degrees of freedom, Grubler's criterion. Inversions of various mechanisms. Quick return motion Mechanisms. Straight line motion mechanisms. Intermittent Motion mechanisms. Toggle mechanism, Pantograph, Steering gears mechanism. Universal Hooke's Joint.	
MODULE 2	**12Hrs**
Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism. Relative velocity and acceleration of particles in a common link and coincident Particles on separate links- Coriolis component of acceleration. Velocity Analysis by Instantaneous Center Method. Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.	
MODULE 3	**12Hrs**
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 various mechanisms with and without friction. Dynamic Force Analysis: D'Alembert's principle, inertia force and torque. Dynamic force analysis of four-bar and slider crank mechanism.	
MODULE 4	**10Hrs**
Static and dynamic balancing. Balancing of single and several rotating mass. Balancing of single cylinder engine: multi cylinder-inline engine (primary & secondary forces), V-type engine. Balancing of locomotives	
MODULE 5	**10Hrs**
Types of cams and followers. Development of cam profile for various types of follower and its different motion. Governors: Types of governors; governor characteristics, force analysis of centrifugal governors. Gyroscope: Vector representation of angular motion. Gyroscopic couple, effect of gyroscopic couple on ship, plane disc, aeroplane,	

TEXT BOOKS :

1. Theory of Machines, Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi,

REFERENCES :

1. Theory of Machines & Mechanisms, J.J. Uicker, G.R. Pennock, J.E. Shigley. Oxford University Press, 4th Edition, 2010.
2. Theory of Machines, Thomas Bevan, CBS Publication 3rd Edition, 2005.
3. Theory of Mechanisms and Machines: Amitabha Ghosh and Ashok kumar Mallik, 3rd Edition Affiliated East-West Press.1976.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19ME3503**					
TITLE OF THE COURSE	**Design of Machine Elements-1**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**1**	**2**	**-**	**70**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV/II	19ME2402	Mechanics of Materials

COURSE OBJECTIVES :

- Understand the stresses in machine members due to various types of loads and failure of components according to theories of failures.
- Analyze the components under variable loading for infinite and finite life.
- Design of machine elements under torsion, bending, axial loads and a combination of these.
- Design of permanent and temporary joints and fasteners for a given load to be transmitted.
- Design of various screws, keys, coupling and shafts.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Classify various stresses acting on a machine element	L2
CO2	Compute the dimensions of component based on the concepts of failure theories	L3
CO3	Interpret different kinds of loading in mechanical engineering components	L3
CO4	Quantify factor of safety, failure modes for mechanical components subjected to direct and bending and combined loading	L3
CO5	Choose the appropriate keys, coupling, shafts and joints in the design of machine components	L2

COURSE CONTENT:	
MODULE 1	**10Hrs**
Normal, shear, biaxial and triaxial stresses, stress tensor, principal stresses. Stress- strain diagrams, stress analysis. Design considerations: Codes and standards, design stress, factor of safety, stress concentration factor in tension, bending and torsion, theories of failures, Static Strength: Static loads, Impact Strength: Introduction, impact	

stresses due to axial, bending and torsional loads, effect of inertia, Failure of brittle and ductile materials	
MODULE 2	**08Hrs**
Introduction, S-N Diagram, low cycle fatigue, high cycle fatigue, 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.	
MODULE 3	**08Hrs**
Threaded fasteners: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static, dynamic and impact loads, design of eccentrically loaded bolted joints. Riveted and Welded Joints: Types, rivet materials, failures of riveted joints, joint efficiency, boiler joints, riveted brackets. Welded Joints: Types, strength of butt and fillet welds, eccentrically loaded welded joints.	
MODULE 4	**08Hrs**
Joints: Types of keys, design of socket-spigot cotter joint, design of knuckle joint. Couplings: Types of couplings, design of flange and flexible couplings and muff coupling	
MODULE 5	**08Hrs**
Shafts: Torsion of shafts, design for strength and rigidity with steady loading, ASME codes for power transmission shafting, shafts under fluctuating loads and combined loads. Curved Beams: Stresses in curved beams of standard cross sections used in crane hook	

List of Laboratory/Practical Experiments activities to be conducted (if any) : 28Hrs	
1.	Determination of principal stresses and strains in a member subjected to combined loading using strain rosettes and verification using FEA tool.
2.	Determination of critical speed of a rotating shaft and verification using FEA tool.
3.	Determination of stresses in curved beam using strain gauge and verification using FEA tool.
4.	Design of Shafts subjected to direct and combined loading for given loads and conditions and comparing design by using CAD/CAE software.
5.	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametric compression. B) Pure bending specimen (four point bending)

TEXT BOOKS :

1. Joseph E Shigley and Charles R. Mischke, Mechanical Engineering Design, McGraw Hill, 6th Edition, 2009.

2. V.B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition 2007.

REFERENCES :

1. Robert L. Norton, Machine Design, Pearson Education Asia, fifth edition, 2014.
2. M. F. Spotts, T. E. Shoup, L. E. Hornberger, S. R. Jayram and C. V. Venkatesh, Design of Machine Elements Pearson Education, Eighth edition 2019.
3. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., Special Indian Edition, 2008.
4. R S Khurmi and J K Gupta, A Textbook on Machine Design, S Chand Publications, Fourteenth Edition 2005.
5. K. Lingaiah, Design Data Hand Book, McGraw Hill, 2nd Edition, 2003.
6. K. Mahadevan and K. Balaveera Reddy, Data Hand Book, CBS Publication, Fourth edition, 2013.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19EME3504**					
TITLE OF THE COURSE	**Manufacturing Technology**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**70**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1.	IV/II	19ME2404	Manufacturing Process

COURSE OBJECTIVES :

- To understand the basic fundamentals and mechanics of metal cutting, tool geometry and life.
- To know the basic knowledge of various machine tools, classification, specification, operations of each machining process like turning, milling, drilling, shaping and grinding operations.
- To impart knowledge on Non-Traditional & CNC machining operation
- To understand the fundamentals of various additive manufacturing technologies for application to various industrial needs

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Choose appropriate machine tools for various machining operations	L3
CO2	Identify traditional machining processes for turning, milling, drilling and grinding operations	L3
CO3	Classify non-traditional machining processes for advanced machining applications	L2
CO4	Analyse working features of CNC machines and part programming	L3
CO5	Describe the methods for manufacture of products using 3D Printing technologies	L2

COURSE CONTENT:	
MODULE 1	**08Hrs**
Types of cutting tool materials, cutting fluids, Single & Multi point cutting tool nomenclature, orthogonal and oblique cutting, mechanism of chip formation, types of chip, merchant analysis, Ernst-merchant's solution, shear angle relationship, problem of merchant's analysis, tool wear and tool failure effects of cutting parameters, tool life criteria, Taylor's tool life equation, problems.	

MODULE 2	**08Hrs**
Lathe Machine: Classification, features, driving mechanisms of lathe and operations on lathe. Drilling machine: Classification, features & operations. Milling: Classification, features, operations, up and down milling, Indexing concepts. Grinding: Types of abrasives, bonding process, structure & types of grinding wheels	
MODULE 3	**10Hrs**
Introduction, Classification, Abrasive jet machining, Ultrasonic machining, Water jet machining, Abrasive Water Jet Machining, Electro chemical machining, Electro Chemical Grinding, Electro-discharge machining, Laser beam machining, Electron Beam Machining, Chemical Milling, Photochemical Milling process characteristics – applications, advantages and disadvantages.	
MODULE 4	**08Hrs**
Fundamentals of numerical control, advantages & classification of NC systems, Functions of MCU, principles of operation features, functions of CNC, Manual part programming, Codes and concepts, point to point and contour programming examples, 2-D simple problems of Drilling, Turning and Milling.	
MODULE 5	**08Hrs**
Introduction, Prototyping fundamentals, Classification, applications, 3D modeling, Data Conversion and transmission, Post processing, RP data formats, Introduction on liquid, solid and powder based additive manufacturing systems, Case studies.	

List of Laboratory/Practical Experiments activities to be conducted (if any) : 28Hrs	
1.	To Study of Mechanism in Lathe and Perform Various Operations on a Lathe Machine.
2.	To study tool wear and tool life measurements for machinability
3.	To Study Construction, Working and Performing Operations on a Drilling & Grinding Machine.
4.	To Study Construction and Working of Milling Machine
5.	To Study Construction, Working and Perform of Shaping Operation on a Shaper Machine.
6.	Introduction of Computer Numerical Control Machines and working of few Models on CNC machine.
7.	Study the mechanism and working of 3D Printing machine.

TEXT BOOKS :

1. Serope Kalpak Jain and Steven R. Schmid, "Manufacturing Engineering and Technology", 7th Edition, Prentice Hall, 2018.

2. P.N. Rao, “Manufacturing Technology – Metal Cutting and Machine Tools,”Volume- II,4 Edition, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2018.

REFERENCES :

1. M. P. Groover, “Fundamentals of Modern manufacturing” -materials, processes and systems Third Edition, Wiley publications, 7th Edition, 2019.
2. Kaushik Kumar, Chikesh Ranjan and Paulo Davim, CNC Programming for Machining, Springer International Publishing, 2020.
3. Ian Gibson, Davin Rosen, Brent Stucker “Additive Manufacturing Technologies- 3D printing, rapid prototyping, direct digital manufacturing”, Springer International Publishing, 2019.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19EME3505**					
TITLE OF THE COURSE	**Special Topics - III**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	-	**1**	**2**	**-**	**42**	**2**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- Student should be able to solve problems in core and intra/inter/multidisciplinary areas
- Student should be aware with current technologies
- Developing critical and creative thinking.
- Work in team environment to develop communication skills

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Define problems in core and interdisciplinary and multidisciplinary areas	L2
CO2	Solve the subjective problem using current technologies	L3
CO3	Demonstrate the interdisciplinary/multidisciplinary approach.	L4
CO4	Prepare documentation for the solution.	L3

COURSE CONTENT:	
MODULE 1	**12Hrs**
Introduction to Python Programming and solving subjective problems.	
MODULE 2	**10Hrs**
Project under the guidance of faculty members on current semester subjects.	
MODULE 3	**10Hrs**
Solving subjective problem using software tools (Ansys, Catia, fusion 360)	
MODULE 4	**10Hrs**
Seminar on projects undertaken.	

PROFESSIONAL ELECTIVE
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SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19ME3506**					
TITLE OF THE COURSE	**REFRIGERATION AND AIR CONDITIONING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV	19ME2401	APPLIED THERMODYNAMICS

COURSE OBJECTIVES :

- Study the methods of refrigeration, Carnot cycle, Unit of refrigeration and coefficient of performance
- Discuss classification and properties of refrigerants
- Describe the Vapour compression and Vapour absorption systems
- Understand psychrometric properties and processes
- Study Air conditioning systems and air conditioning loads
- Understand the measuring instruments and sensors used in air conditioning

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explain different methods of refrigeration	L2
CO2	Select the suitable refrigerant based on application and environmental consideration	L3
CO3	Analyse Vapour compression and Vapour absorption refrigeration systems	L4
CO4	Apply the knowledge of psychrometric properties and processes for air conditioning	L3
CO5	Compute air conditioning loads and Interpret air conditioning methods	L3

COURSE CONTENT:	
MODULE 1	**08Hrs**
Methods of refrigeration, ice refrigeration, evaporative refrigeration, air refrigeration, vapour refrigeration, dry ice refrigeration, pulse tube refrigeration, thermo-acoustic refrigeration, reverse Carnot cycle, block diagram of refrigerator & modified reverse Carnot cycle (Bell Coleman cycle). Unit of refrigeration and coefficient of performance.	

MODULE 2	**08Hrs**
Refrigerants: Classification of refrigerants, desirable properties of refrigerants, environmental issues, Ozone depletion potential and global warming potential & life cycle climate performance. Selection of environment friendly refrigerants, secondary refrigerants, anti-freeze solutions, Zeotropes and Azeotropes.	
MODULE 3	**10Hrs**
Vapour Compression Systems: Vapor compression cycle: p-h and T-s diagrams – deviations from theoretical cycle – sub cooling and super heating-effects of condenser and evaporator pressure on COP- multi pressure system – low temperature refrigeration – cascade systems – problems. Vapour Absorption Systems: Introduction, working of simple vapour absorption system, desirable properties of binary mixture (aqua-ammonia), Lithium-Bromide (Li- Br) absorption system, performance evaluation, applications and comparison between vapour compression system and vapour absorption system.	
MODULE 4	**08Hrs**
Properties of moist air-Gibbs Dalton law, specific humidity, dew point temperature, degree of saturation, relative humidity, enthalpy, humid specific heat, wet bulb temperature thermodynamic wet bulb temperature, psychrometric chart; psychrometric processes.	
MODULE 5	**08Hrs**
Air conditioning: Introduction, Classification, ASHRAE Nomenclature, Applications, Different Air-Conditioning Systems: Central, Unitary, Window, Packaged & Transport Air conditioning loads: Outside and inside design conditions; Sources of heat loads and calculations; Air filters; air conditioning systems with controls: temperature, pressure and humidity sensors, actuators & safety controls.	

TEXT BOOKS :

1. Arora C. P., Refrigeration and Air Conditioning, Tata McGraw-Hill, 2008.
2 Manohar Prasad, Refrigeration and Air Conditioning, Willey Eastern Ltd, 1983.

REFERENCES :

1. Dossat Ray J, Principles of refrigeration, S.I. version, Willey Eastern Ltd, 2000
2. Domkundwar, V.M (2014), Refrigeration and Air-Conditioning Data Book, Dhapapatrai

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19ME3509**					
TITLE OF THE COURSE	**TOOL DESIGN**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
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COURSE OBJECTIVES :

- To understand the various types of tooling materials and their industrial applications.
- To develop capability to design and select single point and multipoint cutting tools for various machining operations.
- Exposure to variety of locating and clamping methods available.
- To enable the students to design jigs and fixtures for simple components
- To expose the students to the design/selection procedure of sheet metal and injection mold

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Select appropriate cutting tools required for producing a component.	L2
CO2	Apply design concepts of single point and multi-point cutting tools	L3
CO3	Demonstrate knowledge of various press tools and sheet tool operations.	L2
CO4	Classify and explain various types of injection moulding dies.	L4
CO5	Analyze and design a jig/fixture for a given simple component	L4

COURSE CONTENT:	
MODULE 1	**08Hrs**

Different tooling materials: cemented carbides, coated carbides, cermet's, ceramics and polycrystalline tool materials. Selection and properties of tool materials, plastics as tool materials, Tooling materials – properties and applications of ferrous, non-ferrous and non-metallic materials. Case studies.	
MODULE 2	**08Hrs**
Design of single point cutting tools - various systems of specifications, geometry and their interrelation, theories of formation of chip and their effect. Design of multipoint cutting tools – Design elements, nomenclature and geometry of drill bit, milling cutter, reamer and broaching tool. Cutting parameters and machining time calculation for drilling, milling, reaming and broaching operation. Case studies	
MODULE 3	**10Hrs**
Working of a power press and classification of presses. Press working terminology, Types of dies-Simple, progressive, compound and combination dies. Components of a simple die, press tool operation, die accessories, press tool operations. Shearing theory, cutting clearance between punch and die, methods of reducing cutting forces, Centre of pressure and problems, scrap strip layout. Design problems on blanking and piercing dies for simple components. Case studies	
MODULE 4	**08Hrs**
Injection moulding machine and its elements, general configuration of a two plate mould. Introduction to gate, runner, parting surface, ejection system. Core and cooling system. Design problems on injection mold. Case studies	
MODULE 5	**08Hrs**
Functions and differences between jigs and fixtures, advantages in mass production, design principles, economics of jigs and fixtures. Location: 3-2-1 Principle of location, different types of locating elements. Clamping: Principles of clamping, types of clamping devices. Drill jigs: Different types, Types of fixtures: Turning fixtures, milling fixtures, grinding fixtures, fixturing for CNC machining centres, and modular fixtures. Case studies.	

TEXT BOOKS :

1. Donaldson. C, Lecain.G.H and Goold.V.C, Tool Design, Tata McGraw Hill publishing company limited, New Delhi, 2002.

REFERENCES :

1. Surendra Kenav and Umesh Chandra, Production Engineering Design (Tool Design), New Delhi, 1994.
2. Mehtha.N.K, Machine Tool Design and Numerical Control, Tata Mc-Graw Hill, Third Edition, 2012.

SEMESTER	**V**					
YEAR	**III**					
COURSE CODE	**19ME3510**					
TITLE OF THE COURSE	**INTRODUCTION TO ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**--**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
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COURSE OBJECTIVES :

- Define machine learning and understand the basic theory underlying machine learning.
- Differentiate supervised, unsupervised and reinforcement learning.
- To present the fundamental principles and practices of AI and ML to address the real-world mechanical engineering problems.
- The course is designed to develop a basic understanding of problem solving, knowledge representation, reasoning and learning methods of AI
- Design and implement a typical AI problem to be solved Using Machine Learning Techniques

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Hand-on experience on Python Programming	L2
CO2	Demonstrate the representation of knowledge and reasoning	L2
CO3	Comprehend the ideas of AI and problem-solving techniques	L3
CO4	Realize Machine Learning techniques in supervised and unsupervised learning	L3
CO5	Recognize the importance of data science, AI & ML in Mechanical Engineering	L3

COURSE CONTENT:	
MODULE 1	**08Hrs**

Introduction, Basics: Basic types, variables, Decision making and Loops, Strings, Data Structures: Lists, Tuples, Sets, and Dictionaries Regular Expression Operations, Modules. Object oriented programming in python: Classes, Constructors, Object Methods.

MODULE 2	**10Hrs**
NumPy - Overview, NumPy Array creation and basic operations, NumPy Universal functions, Selecting and retrieving Data, Data Slicing. Pandas - Overview, Object Creation: Series Object, Data Frame Object, View Data, selecting data by Label and Position, Data Slicing, Setting Data, applying functions to data, Analyzing Data for missing values. Matplotlib - Overview, creating basic chart: Line Chart, Bar Charts and Pie Charts, Plotting from Pandas object, Saving a plot.	
MODULE 3	**08Hrs**
Neural Network basics: History behind neural networks, Relationship between biological neuron and artificial neuron, Perceptron and working mechanism, Architecture of artificial neural network, Types of activation functions, Demo using keras framework, Back propagation and gradient descent, Tensor flow 2.0.	
MODULE 4	**08Hrs**
Introduction to Supervised learning, Linear Regression Logistic Regression, Naive Bayes, Decision Tree, KNN, Random forest, Support Vector Machine Introduction to Unsupervised learning, PCA, clustering approaches: K-means, Hierarchical clustering Natural Language Processing: Natural Language Processing: Language models, n-grams, Vector space models, Bag of words, Text classification. Information retrieval.	
MODULE 5	**08Hrs**
Machine learning application using python for mechanical engineering datasets: mechanical vibrations - heat transfer - fluid mechanics – manufacturing process. Smart Manufacturing, Smart Transportation and Autonomous Vehicles. Robotics, Quality control.	

TEXT BOOKS :

1. Nagy Z. Artificial Intelligence and Machine Learning Fundamentals: Develop real-world applications powered by the latest AI advances. Packt Publishing Ltd; 2018.
2. Sebastian Raschka and Vahid Mir Jalili, Python Machine Learning, Second Edition: Machine Learning and Deep Learning with Python, scikit-learn, and TensorFlow Paperback – September 20, 2017

REFERENCES :

1. David L. Poole, Alan K. Mackworth, Artificial Intelligence: Foundations of

Computational Agents, Cambridge University Press, 2010.
2. Nils J. Nilsson, the Quest for Artificial Intelligence, Cambridge University Press, 2009

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19ME3601**					
TITLE OF THE COURSE	**Design of Machine Elements - II**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**1**	**2**	**-**	**70**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV/II	19ME2402	Mechanics of Materials

COURSE OBJECTIVES :

- To understand use of different types of springs and determine safe design of spring under static and fluctuating loading conditions.
- To understand the standard nomenclature, forces, failures, application, design procedure of Spur and Helical gears (As per AGMA)
- To understand the standard nomenclature, forces, failures, application, design procedure of Bevel and Worm gears (As per AGMA) and to determine standard geometry under given loading condition
- To understand the design procedure, failures and application of Ball Bearings and Sliding contact bearing
- Design clutches and brakes required for power transmission.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Classify different kinds of springs, gears, bearings, clutches and brakes.	L2
CO2	Compute tooth strength for spur, helical, bevel and worm gears	L3
CO3	Interpret the pressure distribution in a journal bearing.	L3
CO4	Analyze the design of hydrodynamic journal bearing.	L4
CO5	Select suitable clutch plate and break shoe for a given applications.	L2

COURSE CONTENT:	
MODULE 1	**08Hrs**
Springs: Types, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, springs under fluctuating loads. Leaf	

springs: Stresses in leaf springs. Equalized stresses, energy stored in springs, torsion, Belleville and rubber springs.
MODULE 2 **10Hrs**
Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear load. Helical Gears: Definitions, formative number of teeth, design based on strength, dynamic and wear loads.
MODULE 3 **08Hrs**
Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic and wear loads. Worm Gears: Definitions, design based on strength, dynamic, wear loads and efficiency of worm gear drives.
MODULE 4 **08Hrs**
Bearings: Lubricants and their properties, mechanisms of lubrication bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, Heat dissipated, bearing materials, examples of journal bearing and thrust bearing design.
MODULE 5 **08Hrs**
Clutches & Brakes: Design of clutches: Single plate, multi plate and cone clutches. Design of Brakes: Block and band brakes: Self-locking of brakes: Heat generation in brakes.

List of Laboratory/Practical Experiments activities to be conducted (if any) :28Hrs	
1.	Determination of pressure distribution in journal bearing
2.	Modelling and stress analysis of Spur and Helical Gear tooth by using CAD/CAE software
3.	Modelling and stress analysis of helical and leaf springs using CAD/CAE software
4.	Modelling and stress analysis of brake by using CAD/CAE software
5.	Modelling and stress analysis of single plate and multi-plate clutches by using CAD/CAE software
6.	Open ended project using FEA software

TEXT BOOKS :

1. Joseph E Shigley and Charles R. Mischke, Mechanical Engineering Design, McGraw Hill, 6th Edition, 2009.
2. V.B. Bhandari, Design of Machine Elements, Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2007.

REFERENCES :

1. Robert L. Norton, Machine Design, Pearson Education Asia, fifth edition, 2014.
2. Machine Design, Hall, Holowenko, Laughlin (Schaum's Outlines series) Adapted by S.K. Somani, Tata McGraw Hill Publishing Company Ltd., Special Indian Edition, 2008.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19ME3602**					
TITLE OF THE COURSE	**Finite Element Methods**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**1**	**2**	**-**	**70**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1.			

COURSE OBJECTIVES :

- To help students to differentiate between finite difference and finite volume methods
- To enable students with the necessary mathematical and theoretical tools and skills required to analyze a wide range two-dimensional real world structural and thermal problems
- To help students understand the use of higher order finite elements

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Differentiate between finite difference and finite volume methods and their applications.	L3
CO2	Analyze a wide range two-dimensional field problems using finite element techniques	L2
CO3	Apply FE techniques to situations involving heat transfer by conduction	L3
CO4	Apply FE techniques in structural and solid mechanics	L3
CO5	Appreciate the use of higher order elements in FEM and apply the same	L3

COURSE CONTENT:

MODULE 1	10Hrs
Introduction to computational methods, Finite difference method, Finite volume methods, Direct stiffness method, Integral formulation for numerical Solution – Variational method, Method of weighted residuals, Potential energy formulations; Principle of virtual work, Division of the region into elements - One dimensional linear element, Linear triangular element, Bilinear rectangular element, Representation for scalar and vector fields, Global, local and natural coordinate systems in one, two and three dimensions.	

MODULE 2	**08Hrs**
Governing differential equations; Integral equations for the element matrices, Triangular element matrix, Torsion of noncircular sections, General theory – Twisting of a square bar, Shear stress components, Evaluation of the twisting torque, Flow of an Ideal Fluid – Potential Formulation, Groundwater Flow, Flow Around a Cylinder, Other field problems, Derivative boundary conditions – 1D, Derivative boundary conditions – 2D,	
MODULE 3	**08Hrs**
Heat transfer by conduction, The one dimensional fin – 1, The one dimensional fin – 2, The composite walls, The two-dimensional fin, Boundary conditions, Long two-dimensional bodies – 1, Long two-dimensional bodies – 2, Axi-symmetric field problems, The differential equation – Axi-symmetric elements, Galerkin's method, Element matrices,	
MODULE 4	**08Hrs**
The axial force member - Element matrices, The truss element – Element matrices, Analysis of a pinned truss – 1, Analysis of a pinned truss – 2, A Beam element,Shape functions, Element matrices, Analysis of a statically indeterminate beam – 1, Analysis of a statically indeterminate beam – 2, A plane frame element – Element matrices, Two dimensional stress analysis - Stress, strain and Hooke's Law, The strain displacement equations, Two dimensional elasticity - Plane stress and plane strain, The displacement equations, The element matrices, Element stresses, Axi-symmetric stress analysis - Element matrices, Surface loads,	
MODULE 5	**08Hrs**
Iso-parametric elements in one and two dimensions, use of higher order elements, Element matrices, Introduction to Transient domain & Dynamic analysis, Changing the variables of integration- One-dimensional integrals, Two-dimensional integrals, Numerical Integration techniques- one-dimensional integrals, Quadrilateral regions, Triangular regions; Evaluating [B]; Evaluating the surface integrals, Pre and post processing, capability of commercially available FEM packages, Error analysis	

List of Laboratory/Practical Experiments activities to be conducted (if any) :28	
1.	Bars of constant cross section area, tapered cross section area and stepped bar
2.	Trusses (Minimum 2 exercises) Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc; (Minimum 6 exercises)
3.	Dynamic analysis 1) Fixed – fixed beam for natural frequency determination 2) Bar subjected to forcing function 3) Fixed – fixed beam subjected to forcing function

	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises)
4.	Stress analysis of a rectangular plate with a circular hole

TEXT BOOKS :

1. "Applied Finite Element Analysis", L.J.Segerlind, John Wiley and Sons
2. "Applied Finite Element Analysis", G.Ramamurthy, I.K.International Publishing House ,2009

REFERENCES :

1. "Concepts and Applications of Finite Element Analysis", Cook, R. D., Malkus, D. S., Plesha, M. E., and Witt, R. J. Wiley Student Edition, Fourth Edition, First Reprint 2007.

2. "The Finite Element Method in Engineering", Rao, S. S., Butterworth-Heinemann (An imprint of Elsevier), Published by Elsevier India Pvt. Ltd., 2007.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19ME3603**					
TITLE OF THE COURSE	**Mechanical Vibrations (Theory & Practice)**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**70**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

- To learn analytical, experimental, and numerical analysis of vibrational phenomena.
- To learn the mathematical modelling of mechanical systems
- To understand the application of the law of conservation of energy in solving problems through energy methods.
- To understand the importance of damping in mechanical systems
- To design the vibration absorbers and isolators
- To acquaint with the principles of vibration measuring instruments

COURSE OUTCOMES :

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Construct mathematical models to represent dynamic systems	L3
CO2	Analyse vibratory responses of single, two and multi degree of freedom mechanical systems	L4
CO3	Demonstrate the knowledge of vibration measuring instruments	L3
CO4	Apply AI techniques to Vibration Analysis of mechanical systems	L3

COURSE CONTENT:	
MODULE 1	**10Hrs**
Introduction, classification of vibration systems, harmonic motion, natural frequency & response, effects of vibration, superposition of simple harmonic motions, Single degree freedom system- equation of motion, Free vibration, equivalent systems, torsional vibrations, vibrations of systems with viscous damping, Logarithmic decrement, energy dissipation in viscous damping.	
MODULE 2	**08Hrs**

Forced vibration, harmonic excitation with viscous damping, steady state vibrations, forced vibrations with rotating and reciprocating unbalance, support excitation,

vibration isolation, transmissibility, displacement, velocity and acceleration measuring instruments.	
MODULE 3	**08Hrs**
Introduction, principal modes, torsional system with damping, coupled system, principle of vibration absorber, undamped dynamic vibration absorbers, torsional vibration absorber, centrifugal pendulum absorbers, vibration isolators and dampers.	
MODULE 4	**08Hrs**
Numerical Analysis- Influence coefficients, reciprocal theorem, torsional vibration of multi-degree rotor system, Rayleigh's method, Dunkerely's, Holzer's and Stodola methods, Rayleigh-Ritz method, critical speed of shafts, whirling of uniform shaft, shaft with one disc with and without damping, multi-disc shafts, secondary critical speed.	
MODULE 5	**08Hrs**
Vibration instruments – transducer, vibrometer, accelerometer, seismometer, vibration pickup, proximity probe spectrum analyzer, principle of seismic instruments, frequency measuring instruments, diagnostic tools, Introduction to condition monitoring and fault diagnosis using Artificial Intelligence approach.	

List of Laboratory/Practical Experiments activities to be conducted (if any) :28Hrs	
1.	Plotting and analysis of various graphs of free and forced vibrations using MATLAB.
2.	Virtual lab exercises provided by MHRD
3.	Free and forced vibration
4.	Whirling of the shaft and finding the critical speed of the shaft.
5.	Students will be trained in MATLAB and ANSYS for solving simple vibration problems and using AI & ML techniques in condition monitoring.

TEXT BOOKS :

1. Rao.S.S, Mechanical Vibrations, 6thEdition, Pearson Education Inc. Delhi 2018.
2. Thomson.W.T, Theory of Vibration and its Applications, 5thEdition, Prentice Hall, New Delhi, 2001.

REFERENCES :

1. Rao.J.S and Gupta.K, Introductory Course on Theory and Practice of Mechanical Vibrations, New Age International, New Delhi, 1999.
2. Ramamurthi.V, Mechanical Vibration Practice with Basic Theory, 1st Edition, Narosa Publishing House, Chennai, 2000.
3. Keith Mobley.R, Vibration Fundamentals, Plant Engineering Maintenance Series, Elsevier, 2007.

4. 4. S.Graham Kelly, Mechanical Vibrations - Schaum's outline series, McGraw Hill, 2007

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19ME3604**					
TITLE OF THE COURSE	**PRODUCT DESIGN AND MANUFACTURING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To expose the students the basics of product design and manufacturing
- To introduce students to the basic principles and evaluation methods of various aspects of designing components
- To teach students about the Industrial manufacturability requirements
- To provide knowledge about emerging technologies such as additive manufacturing, 3D scanning to perform reverse engineering and benchmarking

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Analyse the product life cycle phases of any product and suggest appropriate strategies	L2
CO2	Construct product planning and specification documents	L3
CO3	Demonstrate the knowledge of Architectural and Industrial design aspects of product design	L3
CO4	Apply design for excellence (DF-X) concepts in product design	L3
CO5	Choose an appropriate manufacturing process for product prototyping.	L4

COURSE CONTENT:	
MODULE 1	**08Hrs**

Introduction, Characteristics of successful product development, Design and development of products, duration and cost of product development, challenges of product development. Asimow's Model - Product design practice in Industry -Strength consideration in product design. Product Life Cycle & Strategies at different stages - Case Studies.

MODULE 2	**08Hrs**
Product Planning: product planning process, identify opportunities. Evaluate and prioritize projects, allocate resources and plan timing, complete pre-project planning, reflect all the results and the process. Product design morphology, Visual Design, and Quality Function Deployment (QFD) Product Specifications: specifications, specifications established, establishing target specifications, setting the final specifications, Case Studies.	
MODULE 3	**08Hrs**
Product Architecture: Product architecture, implications of architecture, establishing the architecture, variety and supply chain considerations, platform planning, related system level design issues. Assessing the need for industrial design, impact of industrial design, industrial design process, managing industrial design process and assessing quality of industrial design, Case Studies.	
MODULE 4	**08Hrs**
Design for X (DF-X): (X=Manufacturing & Assembly, Maintenance, Safety, Environment, Quality Estimation of manufacturing cost, reducing the cost of components, assembly, supporting production, impact of DFM on other factors. Design for Production: Forging Design, Pressed Components Design, Casting Design, Design for Machining Ease, Design for PM Parts, Approach to Design with Plastics, Rubber, Ceramics. Case studies.	
MODULE 5	**10Hr**
Prototyping basics, principles of prototyping, technologies, planning for prototypes, advantages and applications. Rapid Prototyping: Two-Dimensional Layer, Techniques- Stereolithography (SL), Solid Foil Polymerization (SFP), Selective Laser Sintering (SLS), Selective Powder Building (SPB), Ballistic Particle Manufacturing (PM), Fused Deposition Modelling (FDM), Laminated Object Manufacturing (LOM), Solid Ground curing (SGC). Reverse Engineering, Case Studies.	

TEXT BOOKS :

1. A C Chitale and R C Gupta, Product Design and Manufacturing **-**, PH1, - 3rd Edition, 2003

REFERENCES :

1. Karl. T. Ulrich, Steven D Eppinger, Product Design and Development - McGraw Hill -2000
2. Tim Jones, Butterworth Heinmann, New Product Development - Oxford. UCI - 1997 3. Geoffery Boothroyd, Peter Dewhurst and Winston Knight, Product Design for Manufacture and Assembly -2002

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19ME3605**					
TITLE OF THE COURSE	**SURFACE ENGINEERING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	-	-	-

COURSE OBJECTIVES :

- To understand the importance of surface modification, fundamental mechanisms of wear and various types of corrosion
- To understand the difference between surface modification and deposition
- To study the vapour deposition techniques
- To understand the thermal spray methods
- To increase the tribological life of materials

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Demonstrate knowledge on Friction, Wear and Corrosion	L3
CO2	Illustrate surface modification processes	L3
CO3	Explain various Surface deposition processes	L2
CO4	Demonstrate the knowledge of thin coatings	L3
CO5	Describe advanced spraying techniques for industrial applications	L2

COURSE CONTENT:	
MODULE 1	**08Hrs**
Introduction - tribology, surface degradation, wear and corrosion, types of wear, adhesive, abrasive, oxidative, corrosive, erosive and fretting wear, roles of friction and lubrication- overview of different forms of corrosion.	
MODULE 2	**08Hrs**
Chemical and electrochemical polishing, significance, specific examples, chemical conversion coatings, phosphating, chromating, chemical colouring, anodizing of aluminium alloys, thermochemical processes -industrial practices.	
MODULE 3	**08Hrs**
Surface pre-treatment, deposition of copper, zinc, nickel and chromium - principles and practices, alloy plating, electro composite plating, properties of electro deposits, electroless composite plating; application areas, properties.	
MODULE 4	**08Hrs**
Definitions and concepts, physical vapour deposition (PVD), evaporation, sputtering, ion plating, plasma nitriding, process capabilities, chemical vapour deposition (CVD), metal organic CVD, plasma assisted CVD.	
MODULE 5	**10Hrs**
Thermal spraying, techniques, advanced spraying techniques - plasma surfacing, detonation gun and high velocity oxy-fuel processes, laser surface alloying, laser cladding, specific industrial applications, tests for assessment of wear and corrosion.	

TEXT BOOKS :

1. Sudarshan T S, Surface modification technologies - An Engineers Guide, Marcel Dekker, Newyork, First edition, 1989.

REFERENCES :

1. D.S.Rickerby and A.Matthews, Advanced Surface Coatings: a Handbook of Surface Engineering, Springer Netherlands, First edition, 1991.
2. Varghese C.D, Electroplating and other Surface Treatments - A Practical Guide", Tata McGraw-Hill, First edition, 1993.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19ME3606**					
TITLE OF THE COURSE	**RENEWABLE ENERGY SOURCES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
-	III/II	19ME2304	THERMODYNAMICS

COURSE OBJECTIVES :

- Describe the environmental aspects of non-conventional energy resources. In Comparison with various conventional energy systems, their prospects and limitations.
- Describe the use of solar energy and the various components used in the energy production with respect to applications like - heating, cooling, desalination, power generation, drying, cooking etc.
- Appreciate the need of Wind Energy and the various components used in energy generation and know the classifications.
- Understand the concept of Biomass energy resources and their classification, types of biogas Plants- applications
- Compare Solar, Wind and bio energy systems, their prospects, Advantages and limitations.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explain the environmental aspects of non-conventional energy resources	L2
CO2	Evaluate the use of solar energy for applications including heating, cooling, desalination, power generation, drying and cooking	L2
CO3	Discuss need of Wind Energy and the various components used in energy generation	L2
CO4	Apply concepts of Biomass energy resources and their classification, types of biogas Plants- applications	L2
CO5	Explain Tidal, OTEC, Hydel, Geothermal and Hydrogen Energy concepts as an alternate energy source	L4

COURSE CONTENT:	
MODULE 1	**08Hrs**
Solar Energy- Solar radiation its measurements and prediction - solar thermal collectors- flat plate collectors, concentrating collectors – applications Principle of photovoltaic conversion of solar energy -Types of solar cells and fabrication -photovoltaic applications - battery charging, domestic lighting, street lighting. Solar PV System Design	
MODULE 2	**08Hrs**
Wind Energy- Wind energy - energy chains - application - historical background, merits and limitations - nature of wind - planetary and local day / night winds - wind energy quantum - power in wind- turbine efficiency - torque thrust calculations - velocity at different heights - site selection - components of wind energy conversion system (WECS). Wind power design calculations.	
MODULE 3	**08Hrs**
Energy from biomass - biomass as renewable energy source - types of bio mass fuels - solid, liquid and gas - biomass conversion techniques- wet process, dry process photosynthesis- biogas generation - factors affecting bio- digestion - classification of biogas plant.	
MODULE 4	**10Hrs**
Tidal Energy: tide – spring tide, neap tide – tidal range – tidal power – types of tidal power plant – single and dual basin schemes –requirements in tidal power plant - ocean thermal energy conversion (OTEC): principle - open and closed OTEC cycles – micro & mini hydel energy: - geothermal energy: geothermal energy sources - power plant and environmental issues. Energy analysis of geothermal plant.	
MODULE 5	**08Hrs**
Hydrogen as a renewable energy source - sources of hydrogen - fuel for vehicles - hydrogen production - direct electrolysis of water, thermal decomposition of water, biological and biochemical methods of hydrogen production - storage of hydrogen - gaseous, cryogenic and metal hydride - fuel cell – principle of working, construction and applications.	

TEXT BOOKS :

1. Tiwari and Ghosal (2007), Renewable energy resources: Narosa publication.

REFERENCES :

1. Twidell& Weir (2015), Renewable Energy Sources: CRC Press.
2. S.P. Sukhatme (2008), Solar Energy/ Tata McGraw-Hill.

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19ME3610**					
TITLE OF THE COURSE	**Internal Combustion Engines**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	IV	19ME2401	APPLIED THERMODYNAMICS

COURSE OBJECTIVES :

- To understand working, and construction of internal combustion engines.
- To understand testing and performance of SI and CI engines.
- To study the combustion phenomenon in SI and CI engines.
- To study sources of emissions from internal combustion engines
- To understand various emission control techniques and emission norms.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Analyse thermodynamic cycles used for IC engine applications	L4
CO2	Explain operating characteristics of different engine and combustion process for SI and CI engines.	L2
CO3	Compare various types of Combustion chambers for IC engine application	L4
CO4	Discuss the various systems used in IC Engine	L2
CO5	Describe the emission norms including Bharat Stage & international norms and Emission control Methods	L2

COURSE CONTENT:	
MODULE 1	**08Hrs**
Heat engine, internal combustion engines and external combustion engines, internal combustion engine construction - components and materials, engine nomenclature, valve timing diagram, intake and exhaust system, engine classification, applications. Fuel air cycle and actual cycle: fuel air cycle, assumptions, comparison with air standard cycle, effect of variables on performance, actual cycle and various losses.	
MODULE 2	**10Hrs**
Theory of carburetion, types of carburetors, electronic fuel injection system, combustion in spark ignition engines, stages of combustion, flame propagation, rate of	

pressure rise, abnormal combustion, phenomenon of detonation in spark ignition engines, effect of engine variables on detonation. Combustion chambers, rating of fuels in spark ignition engines.	
MODULE 3	**08Hrs**
Fuel supply system, types of fuel pump, injector and distribution system, combustion in compression ignition engines, stages of combustion, factors affecting combustion, phenomenon of knocking in compression ignition engine. Effect of knocking, methods of knock control, types of combustion chambers, rating of fuels in compression ignition engines. Dopes &additives, comparison of knocking in spark ignition & compression ignition engines.	
MODULE 4	**08Hrs**
Requirements of combustion chambers, features of different types of combustion chambers system for S.I. engine. I-head, F-head combustion chambers. C.I. engine combustion chambers-air swirl turbulence, M-type combustion chamber. Comparison of various types of combustion chambers.	
MODULE 5	**08Hrs**
Internal combustion, Engine Systems: Cooling system, lubrication system, ignition system, governing system, starting system. Internal combustion engine emissions and control air pollution due to internal combustion engine and its effect, emissions from petrol/gas and diesel engines, sources of emissions, euro norms, Bharat stage norms, emission control methods for spark ignition and compression ignition engines.	

TEXT BOOKS :

1. V. Ganesan(2012, Internal Combustion Engines, Tata McGraw-Hill,

REFERENCES :

1. Heywood(2011), Internal Combustion Engine Fundamentals, Tata McGraw-Hill
2. Colin R. Ferguson C(1986),Internal Combustion Engines, John Wiley & sons

SEMESTER	**VI**					
YEAR	**III**					
COURSE CODE	**19ME3612**					
TITLE OF THE COURSE	**Advanced Material Technology**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1	III	19ME2302	ENGINEERINGMATERIALS

COURSE OBJECTIVES :

- To impart knowledge to students in the latest technological topics on material technology.
- To provide them with opportunities in taking up advanced topics in the field of research.
- To equip students with recent study and advancement on novel materials.

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Summarize the properties of existing and advanced materials	L2
CO2	Classify the existing metallic & non-metallic materials for manufacturing applications	L2
CO3	Discuss the behaviour of materials under various service conditions mechanisms of failure of materials	L2
CO4	Demonstrate micro and nanofabrication techniques and processing of materials	L3
CO5	Analyze the fracture behaviour of materials	L4

COURSE CONTENT:	
MODULE 1	**10Hrs**

Introduction to advanced materials, Super alloys, Ferro electric and piezoelectric materials, Advanced magnetic materials, Smart materials, Motivation for selection, cost basis and service requirements - Selection for mechanical properties, strength, toughness, fatigue and creep - Selection for surface durability corrosion and wear resistance – Relationship between materials selection and processing - Case studies in materials selection with relevance to aero, auto, marine, machinery and nuclear applications.

MODULE 2	**08Hrs**
Modern Metallic materials: Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel - Intermetallics, Ni and Ti aluminides - Smart materials, shape memory alloys – Metallic glass - Quasi crystal and nano crystalline materials, bio materials. Non-Metallic Materials: Plastics, rubber, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, processing and applications.	
MODULE 3	**08Hrs**
Behaviour: Tensile testing, other tests of plastic behaviour, strain hardening of metals, strain rate and temperature dependence, slip, Hardening mechanisms in metals, dynamic strain aging; ductility and fracture, fracture mechanics theories, Creep mechanisms, Mechanical behavior of ceramics and glasses. Performance: Corrosion and its control, Performance of materials at High & low temperatures, Radiation damage and recovery.	
MODULE 4	**08Hrs**
Introduction to Micro and Nano manufacturing technology, advantages and applications of nanotechnology, Overview of Nano Fabrication Methods: Top-down and bottom-up approaches, lithography, deposition, Chemical Vapour Deposition, Physical Vapour Deposition, etching, and material modification methods, processes and equipment.	
MODULE 5	**08Hrs**
Griffith's theory, stress intensity factor and fracture toughness - Toughening mechanisms - Ductile, brittle transition in steel - High temperature fracture, creep - Larson-Miller parameter - Deformation and fracture mechanism maps - Fatigue, low and high cycle fatigue test, crack initiation and propagation mechanisms and Paris law - Fracture of nonmetallic materials – Failure Analysis, sources of failure, procedure of failure analysis	

TEXT BOOKS :

1. Thomas H. Courtney, Mechanical Behavior of Materials , McGraw-Hill, 2000.

REFERENCES :

1. Willam D. Callister, Jr., Material Science and Engineering: An introduction, John Wiley & Sons, Inc, 2003.
2. Willam F. Smith, Principles of Materials Science and Engineering, 3rd edition, McGraw Hill, 2002.

Course: MOOC course – 1

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**MOOC course – 1**
Course Code	**20MDE5301**
Semester	**III Semester**

MOOC Course 1
Machine Design Part I
By Coursera
Syllabus

"Machine Design Part I" is the first course in an in-depth three course series of "Machine Design." The "Machine Design" Coursera series covers fundamental mechanical design topics, such as static and fatigue failure theories, the analysis of shafts, fasteners, and gears, and the design of mechanical systems such as gearboxes. Throughout this series of courses we will examine a number of exciting design case studies, including the material selection of a total hip implant, the design and testing of the wing on the 777 aircraft, and the impact of dynamic loads on the design of an bolted pressure vessel.

In this first course, you will learn robust analysis techniques to predict and validate design performance and life. We will start by reviewing critical material properties in design, such as stress, strength, and the coefficient of thermal expansion. We then transition into static failure theories such as von Mises theory, which can be utilized to prevent failure in static loading applications such as the beams in bridges. Finally, we will learn fatigue failure criteria for designs with dynamic loads, such as the input shaft in the transmission of a car.

Material Properties in Design

In this week, we will first provide an overview on the course's content, targeted audiences, the instructor's professional background, and tips to succeed in this course. Then we will cover critical material properties in design, such as strength, modulus of elasticity, and the coefficient of thermal expansion. A case study examining material

selection in a Zimmer orthopedic hip implant will demonstrate the real life design applications of these material properties. At the end of the week you will have the opportunity to check your own knowledge of these fundamental material properties by taking Quiz 1 "Material Properties in Design."

Static Failure Theories - Part I

In week 2, we will review stress, strength, and the factory of safety. Specifically, we will review axial, torsional, bending, and transverse shear stresses. Please note that these modules are intended for review- students should already be familiar with these topics from their previous solid mechanics, mechanics of materials, or deformable bodies course. For each topic this week, be sure to refresh your analysis skills by working through worksheets 2, 3, 4 and 5. There is no quiz for this week.

Static Failure Theories - Part II

In this week we will first cover the ductile to brittle transition temperature and stress concentration factors. Then, we will learn two critical static failure theories; the Distortion Energy Theory and Brittle Coulomb-Mohr Theory. A case study featuring the ultimate load testing of the Boeing 777 will highlight the importance of analysis and validation. Be sure to work through worksheets 6, 7, 8 and 9 to self-check your understanding of the course materials. At the end of this week, you will take Quiz 2 “Static Failure.”

Fatigue Failure - Part I

In week 4, we will introduce critical fatigue principles, starting with fully revisable stresses and the SN Curve. Then, we discuss how to estimate a fully adjusted endurance limit. Finally, a case study covering the root cause analysis of the fatigue failure of the Aloha Airlines flight 293 will emphasize the dangers of fatigue failure. In this week, you should complete worksheets 10, 11 and 12 as well as Quiz 3 “Fully Reversed Loading in Fatigue.”

Course: DISSERTATION PHASE-1

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**DISSERTATION PHASE-1**
Course Code	**20MDE5302**
Semester	**III Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
12	**-**	**-**	**24**	**24**

Mentoring Hours:
Conduction of Classes: **As per Time Table**

2. COURSE DETAILS

2.1 COURSE OBJECTIVES:

1. To develop the work practice in students to apply theoretical and practical tools/techniques
2. To improve the professional competency
3. To improve research aptitude by touching the areas which otherwise not covered by theory orlaboratory classes.
4. To solve real life problems related to industry and current research.

2.2 COURSE OUTCOMES:

1. Solving of real time problems not necessarily new line of enquiry, but shows that student hasmastered research and synthesizing skills in producing a contribution to knowledge.
2. Builds competency and research aptitude.

The thesis shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed.

Course: MOOC course – 2

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**MOOC course– 2**
Course Code	**20MDE5401**
Semester	**III Semester**

Introduction to Advanced Vibrations by Coursera
Syllabus

About this Course
Introduction to Advanced Vibrations starts with a review of single and double degree of freedom systems. After that, multiple degrees of freedom systems are introduced to explain the vibrations of string and beam. These vibration systems provide to apply or use them into practical problems

Chapter 1- Introduction

- Lecture 1-1 Review of Introduction of General Vibration Systems

Chapter 2 - Vibrations of Linear Multiple-degree-of-freedom System 1: Equations of motion, the stiffness and flexibility methods

- Lecture 2-1 Introduction to Vibration of General Systems
- Lecture 2-2 Basic Vibration of String 1
- Lecture 2-2 Basic Vibration of String 2

Chapter 3 - Vibrations of Linear Multiple-degree-of-freedom Systems 2: Modal analysis

- Lecture 3-1 Review of Basic Vibration of String
- Lecture 3-2 General Vibration of String
- Lecture 3-3 Vibration of General Continuous Systems

Chapter 4 - Vibrations of Continuous Systems 1: The vibration of string

- Lecture 4-1 Review of Continuous systems
- Lecture 4-2 Vibration of General Systems

Chapter 5 - Vibrations of Continuous Systems 2: The vibration of beam

- Lecture 5-1 Vibration of General System 2
- Lecture 5-2 Summary of Vibration of General Systems

School	**School of Engineering**
Department	**Mechanical Engineering**
Programme	**M. Tech programme**
Specialization	**Design Engineering**
Course Title	**DISSERTATION PHASE-2**
Course Code	**20MDE5402**
Semester	**IV Semester**

1. Course Size and Instruction Method

Credits	L	T	P	Hours/Week
12	**-**	**-**	**12**	**12**

Mentoring Hours:

Conduction of Classes: **As per Time Table**

2. COURSE DETAILS

2.1 COURSE OBJECTIVES:

The dissertation demonstrates the student's mastery of relevant resources and methods.

1. An ordered, critical exposition of knowledge gained through student's own effort.
2. Demonstrates sound under-standing of research process.
3. Demonstrates knowledge of appropriate methodology.
4. Demonstrates ability to present study in a disciplined way in scholarly conventions of thediscipline.
5. Ability to make critical use of published work.

2.2 COURSE OUTCOMES:

1. Improves the professional competency and research.
2. Develops the work to apply theoretical and practical tools/techniques
3. Solve problems related to industry and current research.
4. Possible publication in journal or conferences.

2.3 THE REPORT GENERALLY CONTAINS:

1. Cover
2. Title page
3. Certificate(s)
4. Acknowledgements
5. Abstract
6. Contents page
7. List of figures or Tables

8. Introduction
9. Literature survey
10. Methodology
11. Results and Discussion
12. Conclusion and scope of future work.
13. Reference list / Bibliography
14. Appendices.

2.4 Avoiding plagiarism

1. Plagiarism is taking the words, theories, or ideas of another person and passing them off as yourown.
2. Plagiarism can be copying inadvertently/advertently a passage from a book or journal or pastingsomething from the internet into report without referencing the original source.
3. Plagiarism can also result from wrong referencing.

2.5 Avoiding plagiarism

The guide/supervisor shall certify that the report is checked for plagiarism and is within 25% of thecontent.

The thesis shall consist of research work done by the candidate or a comprehensive and critical reviewof any recent development in the subject of specialization or a detailed report of project work consistingof experimentation/numerical work, design and or development work that the candidate has executed.It is expected that students should refer national and international journals, proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work/experimentation carried out on the thesistopic. Student should submit the thesis covering the content discussed above and highlighting the features of work to be carried out in the thesis. Student should follow standard practice of thesis writing.At the end of successfully finishing the work he/she has to submit a detailed report and has to present for a viva–voce.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20ME2302**					
TITLE OF THE COURSE	**ENGINEERING MATERIALS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**70**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course
1			

COURSE OBJECTIVES:

The objectives of the Course are to

- Describe the difference in atomic/molecular structure between crystalline and non-crystalline materials.
- Describe the tensile, compression, shear and bending deformations of the metalspecimen and to describe the changes in specimen profile up to the point of fracture.
- Determine the various phases present, composition and the mass fractions of thephases from a binary phase diagram.
- Name different kinds of steels, cast irons and non-ferrous alloys, and for each cite distinctive properties and typical uses.
- Understand the types and applications of ceramics and polymers.
- Learn the different manufacturing processes for composite materials.
- Familiarize with the testing standards for mechanical characterization

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Classify engineering materials based on their crystalstructure	L2
CO2	Calculate the material properties through testing of materials	L3
CO3	Interpret phase diagram for alloy preparation	L2
CO4	Relate the phase diagram, microstructure and themechanical properties of materials	L3
CO5	Select material for an application by analysing therequirements with the material properties	L1
CO 6	Prepare polymer composites by hand lay-up, vacuumagging, resin transfer moulding and filament winding processes	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**

Introduction to materials, Overview of Crystal Structure, Solid Solutions, Hume Rothery Rules,Crystal Imperfections, Critical nucleus size and Critical Free energy,Mechanism of Crystallization, Nucleation, Nucleation- Growth, Single crystal, Polycrystalline Materials, Basic principles of solidification of metals and alloys. Solidification time, Cooling curves, Non- crystalline solids.	
MODULE 2	**8Hrs**
Testing of materials under tension, compression and shear loads, Hardness tests, fatigue and creep test. Impact testing, Fatigue testing, Fracture, Types, Fracture mechanics. Characteristics of creep curve & steady state creep. Fracture toughness & fatigue, Stress and temperature effects.	
MODULE 3	**10Hrs**
Equilibrium phase diagrams. Particle strengthening by precipitation. Precipitation reactions. Phase Rule, Unary System, Binary Phase diagrams, Iron-carbon system. Phase transformations. Transformation rate effects and Isothermal transformations (TTT Curves), Continuous cooling transformations, Microstructure and property changes in iron- carbon system, Iron-carbon equilibrium diagram, Heat treatments.	
MODULE 4	**8Hrs**
Classification of steels and cast iron, Microstructure, Effect of alloying elements on steel, Ferrous alloys and their applications, High Resistivity and High temperature alloys, Selection of material for various applications- case studies.	
MODULE 5	**8Hrs**
Ceramics, Glass Ceramics, Advanced ceramics, Functional properties and applicationsof ceramic materials and Glasses, Polymers, Composites, Nanomaterials, Materials used in additive manufacturing.	

List of Laboratory/Practical Experiments activities to be conducted : 28Hrs
1. Tension Test- To understand the tensile characteristics of mild steel through tensile testing and thereby determine mechanical properties such as ultimate tensile strength, elastic modulus, proportionality limit, yield point, fracture stress, percentage elongation & reduction in area.
2. Compression Test- To determine the compressive strength of aluminium and cast-iron specimens and to identify the failure modes of ductile/brittle materials through evaluation of their failure modes of above material.
3. Shear Test - To determine ultimate shear strength of aluminium under single and double shear.
4. Bending Test - To investigate the relationship between load and span on deflection of a simply supported beam subjected to a concentrated load at the centre. Also,evaluate the modulus of elasticity of the given beam from the test data.
5. Impact Test (Charpy and Izod) - To evaluate the energy absorbed during failure of a notched specimen subjected to pendulum impact testing.
6. Brinell hardness Test -To determine the Brinell Hardness Number (BHN) of the given specimens.
7. Vicker's Hardness Test - To determine Vickers Hardness Number for a given specimen.
8. Wear Test - To understand the parameters that affect the wear rate using pin anddisc apparatus.
9. Composite preparation- preparation of polymer composites through hand lay-up, vacuum bagging and resin transfer moulding process.
10.Demonstration of 3D printing of given polymer/metal/ceramic specimens.

TEXT BOOKS:

1. William D. Callister, Jr.(2020) "Materials Science and Engineering anIntroduction", 2nd Edition, John Wiley & Sons, Inc.

V. Raghavan (2019), "Materials Science and Engineering", Prentice – Hall of IndiaPvt. Ltd.

2. V. Raghavan (2019), "Materials Science and Engineering", Prentice – Hall of IndiaPvt. Ltd.

REFERENCES:

1. J.M. Shackelford (2014), Introduction to Materials Science for Engineers, 5thEdition, Prentice Hall, Inc.
2. Suryanarayana, A. V. K. (2020), Testing of Metallic Materials, Prentice Hall India,New Delhi.
3. W. Bolton (2013), Engineering materials technology, 3 rd Edition, Butterworth &Heinemann.

SEMESTER	**III**
YEAR	**II**

COURSE CODE	20ME2303					
TITLE OF THE COURSE	ENGINEERING MECHANICS					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3		**-**	**-**	**42**	**3**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES :

The objectives of the Course are to

- Explain different types of forces and couples, resolution of forces and couples,equilibrium conditions and related theorems
- Explain concepts of friction and their relevance in Engineering problems
- Describe centroid, center of gravity and differences between them, area moment ofinertia, examples of planar objects and computations for them
- Describe Trusses and its classification, assumptions in analysis of trusses, forces inmembers in a truss
- Calculate various dynamic quantities of translational motion and projectile motion
- Explain principles of dynamics in plane motion analysis

COURSE OUTCOMES:

CO No.	Outcomes	Bloom's Taxonomy Level
CO1	Analyze structure using free body diagrams andprinciple of statics	L3
CO2	Analyze structures using concept of equilibriumconditions considering effect of frictional forces	L3
CO3	Calculate the centroid and moment of inertia ofcomposite geometrical sections	L3
CO4	Compute axial forces in members of determinatetruss	L3
CO5	Analyze plane kinematics and kinetics ofparticles/rigid bodies	L3

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

COURSE CONTENT:
Equilibrium.
MODULE 1 **8Hrs**
MODULE 2 **8Hrs**
Friction: Introduction, Types of friction, Limiting friction, Cone of Friction, Laws ofFriction, Static and Dynamic Friction; Motion of Bodies, wedge friction, Ladder friction, related problems.
MODULE 3 **10Hrs**
Centroid, Centre of Gravity and Moment of Inertia: Introduction, Centroid of simple figures from first principle, centroid of composite sections; Centre of Gravity and its implications; Area moment of inertia Definition, Moment of inertia of plane sections from first principles, Theorems of moment of inertia, Moment of inertia of standard sections and composite sections; Mass moment inertia of circular plate, Cylinder, Cone.
MODULE 4 **8Hrs**
Analysis of Truss: Introduction, Classification of trusses, Equilibrium in two and three dimension; Method of Sections; Method of Joints; To determine if a member is in tensionor compression; Simple Trusses; Zero force members.
MODULE 5 **8Hrs**
Dynamics: Introduction, Rectilinear motion; Plane curvilinear motion (rectangular path, and polar coordinates); Projectile motion, Relative and constrained motion; Basic terms, general principles in dynamics; Types of motion, Instantaneous Centre of rotation in plane motion and simple problems; D Alembert's principle and its applications in plane motion and connected bodies.

TEXT BOOKS:

1. A. Nelson (2009), Engineering Mechanics: Statics and dynamics, Tata McGraw Hillpublications.
2. Irving H. Shames (2006), Engineering Mechanics, 4th Edition, Prentice Hallpublications.

REFERENCES:

1. R.C. Hibbler (2006), Engineering Mechanics: Principles of Statics and Dynamics,Pearson Press.
2. Bansal R.K (2010), A Text Book of Engineering Mechanics, Laxmi Publications.
3. H.J. Sawant, S.P Nitsure(2018), Elements of Civil Engineering and EngineeringMechanics, Technical Publications.
4. www.dsu.edu.in

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20ME2305**					
TITLE OF THE COURSE	**COMPUTER AIDED MACHINE DRAWING**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**-**	**4**	**-**	**84**	**4**

Perquisite Courses (if any)			
#	Sem/Year	Course Code	Title of the Course

COURSE OBJECTIVES:

The objectives of the Course are to

- Provide overview of various CAD software
- Learn basics of sketching features
- Create 3D models using extrude, revolve, draft & other advanced options
- Introduce assembly concepts
- Create simple & complex mechanical assemblies
- Create industrial standard drawings with appropriate views including sectional views

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Discuss different types of CAD tools	L2
CO2	Create 2D geometric sketches by Autodesk FUSION360.	L3
CO3	Develop 3D models of components using basic andadvanced features	L4
CO4	Create different types of assemblies usingappropriate constraints	L3
CO5	Produce BOM and manufacturing drawingsusing appropriate views, symbols & tolerances	L2
CO 6	Discuss applications of CAD data exchange formats	L2

COURSE CONTENT:	
MODULE 1	**10Hrs**
CAD Overview: Preferences-Settings, User Interface- Familiarize the User Interface by creating a simple design, Use of toolbar, marking menu, browser and time line controls, change of workspace, Navigations and data panel interface, Design Units and Origin, Quick Shape Creation.	
MODULE 2	**10Hrs**

Sketching Workspace: Creating a sketching geometries - Introduction to the Sketching Workflow, Sketch Entities, Dimensioning, Sketch Constraints. Additional Sketching. Tools- Additional Entity Types, Editing Tools, Additional Dimension Tools, Moving and Copying, Rectangular and circular Patterns. Sketched Secondary Features using existing geometry. Pick and Place Features- Fillets, Chamfers, Holes, Editing Pick and Place Features. Construction of planes, axis and points, creating a sketch using Equation and Parameters.

MODULE 3	**12Hrs**

Introduction-Solid Modeling techniques: Constructive Solid Geometry using primitives, Boundary representation & Hybrid methods. Basic Part modelling features- Extrude and revolve. Additional Features and Operations- Draft, Shell, Rib, Split Face, Scale, Thread, Press Pull. Design and Display Manipulation- Reordering, inserting, suppressing Features, Measure and Section Analysis, Direct Modeling Development of multi section solids and sweep. Feature Duplication – mirroring and patterning.
Develop the part models and prepare the drafting. List out the operations involved to prepare the components.

MODULE 4	**12Hrs**

Distributed Design- Assembly Design Methods, Joint Origins and Assigning Joints. Component Design Tools- Rigid Groups, Interference Detection. Multi-Body Design- Multi-Body Design Tools, Components, As-Built Joints.Drawing Basics-Creating a New Drawing, Additional Drawing Views, Exploded Views, Manipulating Drawings. Detailing Drawings- Dimensions, Parts List and Balloons, Annotation and Dimension Settings, Drawing Output. Data exchange standards – IGES, STP, STL, STEP etc.
Develop the assembly drawing from the given detailed drawing(Machine components upto five major parts). Indicate the empirical relations along with actual dimensions and bill of materials. Layout the drawings in A3 sheet.

MODULE 5	**40Hrs**

Assembly of Machine Parts: Develop the assembly drawing from the given detailed drawing showing conventional representations with geometrical and dimensional constraints. Prepare the bill of materials for the given assembly

1. Swivel bearing
2. Petrol engine connecting rod
3. Cylinder relief valve
4. Machine vice
5. Tailstock
6. Piston of a petrol engine
7. Air valve
8. Fuel Injector
9. Speed reducer
10. Drill jig

Layout the drawings in A1 sheet.

TEXT BOOKS:

1. K. R. Gopalakrishna (2017) “Machine Drawing in First angle projection”, Subhaspublication,

Bangalore.
2. N.D.Bhat & V.M.Panchal (2016), “Machine Drawing”, Charotar Publishing House.

REFERENCES:

1. Basant Agrawal & C M Agrawal (2017) “Engineering Drawing, 2nd Edition ”,Mc.Grawhill.

SEMESTER	**III**					
YEAR	**II**					
COURSE CODE	**20ME2306**					
TITLE OF THE COURSE	**MECHANICAL MEASUREMENTS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	**-**	**2**	**-**	**70**	**4**

COURSE OBJECTIVES:

The objectives of the Course are to

- Introduce the measurement quantities and measurement standards
- To Study the limits, fits, tolerances and gauges
- Learn the concept of slip gauges and wringing phenomenon
- Study the different types of mechanical and electrical compactors
- Illustrate the linear and angular measurements
- Determine the primary detector-transducers, intermediate signal processing systemand terminal systems
- Provide the necessary skills for calibration and testing of different gauges andinstruments.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explain measurement standards and system	L2
CO2	Calculate the uncertainty in measurements	L3
CO3	Explain tolerance, limits of size, fits, gauges and the various advancement in laser Interferometers, CMM,Machine Vision Systems	L2
CO4	Describe generalized measurement system highlighting various types of sensors, Identify transducers, signal conditioning components, and different types of presentation devices. measurement of temperature, pressure	L2
CO5	Calibrate various measuring devices and errors and correction factors of various measuring devices	L2
CO 6	Compute the linear and angular measurements and demonstrate the necessary skills to collect data, perform analysis and interpret results to draw validconclusions through standard test procedures.	L2

COURSE CONTENT:	
MODULE 1	**9Hrs**

Standards of Measurements in Meteorology: Definition, objectives and concept of metrology, role of standards, standards of length Principles, light wave length
standards, subdivision of standards, calibration of standards, numerical problems, slip gauges, set of gauges, wringing phenomena, manufacture of slip gauges. Numerical problems on building of slip gauges, Comparators - mechanical, electrical, pneumatic and optical comparators.
MODULE 2 **9Hrs**
System of Limits, Fits, Tolerance and Gauging: Indian standards, concept of limits of size and tolerances, interchange ability, selective assembly definition of fits, hole basis system, shaft basis system, types of fits and their designation, geometric tolerance. Classification of gauges, brief concept of design of gauges (Taylor's principles),Numerical problems Advances in Metrology Basic concept of lasers Advantages of lasers, laser Interferometers. Basic concept of CMM, Types of CMM.
MODULE 3 **8Hrs**
Measurement systems and its basic concepts: Definition, significance of measurement, fundamental method of measurements, generalized measurement system, definitions and basic concepts, Linear Measurement and angular measurements. Errors in measuring instruments, classification of errors, sources of errors and uncertainty.
MODULE 4 **8Hrs**
Introduction to transducers and intermediate modifying devices: Introduction to Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers, Intermediate modifying devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers. Terminating devices, Cathode ray oscilloscope
MODULE 5 **8Hrs**
Temperature and Strain Measurements: Temperature Measurement: Resistance thermometers, thermocouples, laws of thermocouple, materials used for construction, pyrometer, optical pyrometer, Strain Measurement: Theory of strain gauges, types, preparation and mounting of strain gauges, gauge factor, Temperature Compensation, Wheatstone bridge circuit.

List of Laboratory/Practical Experiments activities to be conducted (if any) :28Hrs
1. Calibration of Micrometer - To calibrate the given micrometer using slip gauge,draw the calibration curve and to evaluate the errors occurred.
2. Calibration of Vernier caliper and measurement of the given component - To calibrate and measure the given component by using Vernier caliper.
3. Calibration of Thermocouple - To calibrate the given T-Type Thermocouple at different temperatures.
4. Calibration of Linear Variable Differential Transformer (LVDT) - To calibrate thegiven LVDT (for the performance using Vernier height gauge.
5. Calibration of Load Cell - To calibrate the given Cantilever Beam type load cell.
6. Measurements using Optical Profile Projector – To measure the screw thread parameters of a given specimen using Optical Profile projector.
7. Measurements using Toolmaker's Microscope - To measure the screw thread parameters of a given specimen using Tool Maker's Microscope.

8. Measurements of angle using Sine bar - To determine the unknown angle of thegiven specimen using sine bar with the help of slip gauge.
9. Measurements of angle using universal bevel protractor - To determine the unknown angle of the given specimen using universal bevel protractor.
10. Measurements of Screw thread parameters using two wire or three-wire methods - To find the effective diameter of a given screw thread by two or three wiremethod.
11. Measurements of gear tooth profile using gear tooth Vernier caliper - To Measurethe tooth thickness of the given gear using Gear Tooth Vernier Caliper.
12. Measurements of Vibrations - To study the vibrations measurement, frequency, displacement, velocity & acceleration.
13. Machine tool alignment test on a) Lathe. b) Drilling machine. c) Milling machine. d) CNC milling.

TEXT BOOKS:

1. Beckwith Marangoni and Lienhard (2006), Mechanical Measurements, PearsonEducation, 6th Edition.
2. R.K. Jain (2009), Engineering Metrology, Khanna Publishers, New Delhi.

REFERENCES:

1. S.P. Venkatesh(2008), Mechanical Measurements, ANE Publications
2. Ernest O. Doebelin (2019), Measurement Systems: Application and Design, SIEPublications.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20ME2401**					
TITLE OF THE COURSE	**APPLIED THERMODYNAMICS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**1**	**2**	**-**	**70**	**4**

COURSE OBJECTIVES :

The objectives of the Course are to

- Understand Gas power cycles like Otto, Diesel, Dual and Brayton cycles and calculationof heat, work interactions and thermal efficiency
- Understand Vapour power cycles and calculation of heat, work interactions andthermal efficiency
- Understand the effect of inlet pressure and temperature on the performance of vapourpower cycles
- Understand the operation of combined cycle with toping gas turbine and bottomingsteam cycle
- Explain the working of a single stage and multistage compressor and to calculate workdone, volumetric-isothermal-polytropic efficiencies
- Understand refrigeration cycle and calculation of COP and to study different types of refrigerants and to appreciate the use of eco-friendly refrigerants
- Study combustion thermodynamics of fuels
- Carry out tests to investigate the performance of internal combustion engines

COURSE OUTCOMES :

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Calculate work obtained, mean effective pressure and thermal efficiency for Otto, Diesel , Dual and Bryton cycles, Thermal efficiency of Basic, modified , reheat and regenerative Rankine cycles	L3
CO2	Calculate the work done and efficiency for single stageand multistage compressor	L3
CO3	Analyze different refrigeration and air-conditioningcycles	L3
CO4	Analyze combustion thermodynamics of fuels	L3
CO5	Estimate the properties of fuels and lubricants likeflash and fire point, viscosity and calorific value.	L2
CO6	Predict I C engine performance parameters at differentoperating conditions and also to carry out heat balance	L3

COURSE CONTENT:	
MODULE 1	**8Hrs**
Gas Power Cycles Review of thermodynamics laws, Carnot, Otto, Diesel and Dual Cycles; simple Gas turbine cycle (Brayton cycle) and Modifications; Multistage compression with intercooling, Regeneration, reheat cycles practical gas turbine, cycles; Jet Propulsion cycles	
MODULE 2	**10Hrs**
Vapour Power Cycles and Combined cycle power plants Components of steam power plant, Carnot vapour power cycles, limitation of Carnot cycle, Simple Rankine cycle; Effect of pressure and Temperature on performance of Rankine Cycle, Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycles, feed water heaters. Reheat Rankine cycle, Supercritical Rankine cycle, combined gas and vapour cycle power plants. Numerical	
MODULE 3	**8Hrs**
Reciprocating Compressors Classification; work done in a single stage compressor; efficiency; p-v diagram for an actual compressor and diagram factor; multistage compressor; Multistage compressor with intercooler, Performance parameters for reciprocating compressors	
MODULE 4	**8Hrs**
Refrigeration and Air conditioning Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Vapour absorption refrigeration system. Psychrometric: Nomenclature, Definition, use of Psychrometric chart, Introduction to air conditioning, different types of air-conditioning systems	
MODULE 5	**8Hrs**
Combustion Thermodynamics Theoretical (Stoichiometric) air for combustion of fuels. Excess air, mass balance, Exhaust gas analysis, A/F ratio. Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion. Combustion efficiency. Dissociation and equilibrium, emissions.	

List of Laboratory/Practical Experiments activities to be conducted (if any) : 28Hrs
Determination of Flash point and Fire point of lubricating oil using Abel, Pensky and Marten's (closed) / Cleavland's (Open Cup) Apparatus.
Determination of Calorific value of solid, liquid and gaseous fuels.
Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers.

Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke).

Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal
Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A-F Ratio, heatbalance sheet.

TEXT BOOKS:

1. Kadambi, T. R Seetaraman and K. B Subramanya Kumar (2019), Applications of Thermodynamics, Wiley India Private Ltd, New Delhi.
2. Nag P.K (2017), Basics and applied thermodynamics, Second edition, Tata McGrawHill, New Delhi.

REFERENCES:

1. Yunus A Cengel and Michael A Boles (2017), Thermodynamics: An EngineeringApproach, McGraw Hill Education.
2. Michael J. Moran and Howard N. Shapiro (2006), Fundamentals of Engineering Thermodynamics, John Wiley & Sons Ltd.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20ME2402**					
TITLE OF THE COURSE	**MECHANICS OF MATERIALS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	2	**1**		**-**	**42**	**3**

COURSE OBJECTIVES :

The objectives of the Course are to

- Explain mechanical properties of materials, Stress, Strain and Hooke's law
- Explain principal stresses, maximum shear stress, principal planes and Mohr's circlefor plane stress conditions
- Draw shear force and bending moment diagrams in beams to estimate maximumshear forces and bending moment
- Explain torsional moment of resistance, power transmission of straight and steppedshafts, twist in shaft sections
- Explain strain energy due to axial, shear, bending, torsion and impact load
- Explain theories of failure as applied to materials
- Explain mechanical properties of materials, Stress, Strain and Hooke's law
- Explain principal stresses, maximum shear stress, principal planes and Mohr's circlefor plane stress conditions

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Calculate stress and strain for different geometriesunder different loading conditions	L3
CO2	Illustrate principal stresses, maximum shearing stress acting on a structural member using analyticaland Mohr's circle method	L2
CO3	Calculate the stresses and strains associated with thin and thick cylindrical pressure vessels under axial andcircumferential loads	L3
CO4	Construct shear force and bending moment diagramsfor statically determinate beams	L3
CO5	Calculate the shear stress for bodies subjected to torsion and bending stresses for columns	L3
CO6	Discuss theories of failure as applied to materials	L2

COURSE CONTENT:	
MODULE 1	**8Hrs**

Stress and Strain

Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Shear stress and strain,Lateral strain and Poisson's ratio, Elastic constants and relations between them.

Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change.

MODULE 2	**10Hrs**

Analysis of Stress and Strain

Compound Stresses: Principal stresses and maximum shear stress, Planes of Principal stress and Maximum Shear stress, Normal stress on the planes of maximum shear stress, Mohr's circle for plane stress conditions.

Cylinders: Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, thin spherical Shell, thin cylinder with spherical ends. Thick cylinders: Lame's theory.

MODULE 3	**8Hrs**

Shear Forces and Bending Moments

Shear Forces and Bending Moments: Type of beams, Loads and reactions, Relationship between loads, Shear force and bending moments of cantilever, simply supported and overhanging beams subjected to concentrated loads and uniformly distributed constant / varying loads.

Stress in Beams: Bending Theory**,** Bending and shear stress distribution in rectangular,I and T section beams.

MODULE 4	**8Hrs**

Torsion

Torsion: Circular shafts, Power Transmission, Torsion of tapered shaft, Shafts inseries andParallel, Thin Tubular and Thin-walled sections.

Columns: Euler's theory, Equivalent Length, Limitations of Euler's Formula,Rankines Formula

MODULE 5	**8Hrs**

Strain Energy

Strain Energy: Strain energy due to axial, shear, bending, torsion and impact load, Castigliano's theorem and their applications.

Theories of Failure: Introduction, maximum principal stress theory (Rankine's theory), Maximum shearing stress theory (Guest's and Tresca's theory), maximum principal strain theory (St. Venant's theory), Maximum Strain energy theory (Haigh's Theory) and Maximum Shear Strain Energy Theory (Mises' and Henkeys's Theory)

TEXT BOOKS:

1. Stephen Timoshenko (2002), Strength of Materials, 3rd Edition, CBS Publisher.
2. S. S. Bhavikatti (2017), Mechanics of Solids, New Age International Publications.

REFERENCES:

1. F. P. Beer and E. R. Johnston (2020), Mechanics of Materials, 8th Edition,McGraw Hill publications.
2. R. K. Bansal (2010), A Textbook of Strength of Materials, 4th Edition, LaxmiPublications.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20ME2403**					
TITLE OF THE COURSE	**FLUID MECHANICS AND MACHINES**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	**2**	**-**	**70**	**4**

COURSE OBJECTIVES:

The objectives of the Course are to

- Define basic properties of fluids and understand the continuum approximation.
- Define kinematics of Fluid Flow
- Describe Lagrangian and Eulerian Approach for fluid flow
- Buckingham's Pi theorem
- Apply dimensional analysis to design new pumps or turbines that are geometricallysimilar to existing pumps or turbines
- To study the performance parameters of Reciprocating , Centrifugal and Gear pumps
- To study the performance parameters of Impulse and Reaction turbines like Peltonwheel turbine, Francis turbine and Kaplan turbine
- Define basic properties of fluids and understand the continuum approximation.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Define fluid, fluid properties and express fluidproperties in terms of various measurable parameters	L1
CO2	Explain fluid dynamics and develop relevant fluid dynamic relations considering continuity, momentumand energy equations, apply the relations for analysis of dynamic forces and flow through variousgeometries	L2
CO3	Apply concepts of dimensional analysis to develop mathematical relations for various fluid flowsituations	L3
CO4	Explain working principles of hydraulic turbomachinery and calculate the power and efficiencies involved in operations of machines andlearn concepts of compressible flow	L2

CO5	Calculate flow rates of fluids using Orifice meter,Venturimeter, Notches, Rotameter, losses in pipe	L3
CO6	Study the performance parameters of Reciprocating , Centrifugal and Gear pumps, Impulse and Reactionturbines like Pelton wheel turbine, Francis turbine	L1

COURSE CONTENT:

MODULE 1	**8Hrs**

Fluid Properties and Fluid Statics

Introduction, properties of fluids, viscosity, thermodynamics properties, surface tension and capillarity, vapour pressure. Types of fluid flows Fluid pressure at a point, Pascal's law, pressurevariation in a static fluid, absolute, gauge, atmospheric and vacuumpressures, Fluid Statics: Fluid pressure at a point, Pascal's law, pressure variation in a static fluid.

MODULE 2	**10Hrs**

Fluid Kinematics and Dynamics

Fluid Kinematics- Introduction, Lagrangian and Eulerian Approach for fluid flow, Continuity equation Velocity and acceleration in a flow field, Potential and stream function, Fluid Dynamics

Introduction, Equation of motion, Euler's equation of motion, and Bernoulli's equation derived from fundamental &Euler's equation, Bernoulli's equation for real fluids. Fluid Flow measurements-Venturimeter, orifice meter and Pitot tube. Flow through Pipes-Major & Minor losses in pipe flow. Numerical exercise.

MODULE 3	**8Hrs**

Dimensional Analysis and Boundary Layers

Introduction, Dimensional homogeneity –Buckingham theorem – Non-dimensional numbers – Model laws; Unit Quantities and Specific quantities, introduction to boundary layer theory –Laminar flow and Turbulent flow – Boundary layer thickness.

MODULE 4	**8Hrs**

Hydraulic Turbines

Euler's Turbine equation,Classification of turbines, Impulse and reaction turbines, Pelton wheel, Francis and Kaplan turbine –work done and efficiencies. Draft tube theory, Performance of hydraulic machines, unit and specific quantities, turbine governing.

MODULE 5	**8Hrs**

Pumps

Classification, working, work done – monometric head- losses and efficiencies- specific speed- pumps in series and parallel-performance characteristic curves, NPSH. Reciprocating pumps: Working, Discharge, slip.

List of Laboratory/Practical Experiments activities to be conducted (if any) : 28Hrs

1. Rotameter

Calculation of the Rate of Flow Using Rotameter

2. Venturimeter

Determination of the Co- Efficient of Discharge of the Venturimeter

3. Orifice Meter Determination of the Co-Efficient of Discharge of the Given Orifice Meter
4. Pipe Friction Determination of frictional loss in a pipe flow
5. Pipe Fittings Determination of Loss of Head on Pipe Fittings
6. Notch Determination of Co- efficient of Discharge of the Given Notch
7. Centrifugal Pump Study of Performance Test On Centrifugal Pump
8. Reciprocating Pump Study of Performance Test On Reciprocating Pump
9. Gear Pump Test Rig Study of Performance Test On Gear Pump
10. Pelton Wheel Turbine Study of Performance Test on Pelton Wheel Turbine
11. Francis Turbine Study of Performance Characteristics Curves of Francis Turbine

TEXT BOOKS:

1. Bruce R. Munson, Donald F. Young, Theodore H. Okiishi, Wade W. Huebsch (2009)
2. Fundamentals of Fluid Mechanics, John Wiley & Sons Publications.Frank M White (2011),
3. Fluid Mechanics, McGraw-Hill Publication, Seventh Edition

REFERENCES:

1. Jagdish Lal (2016) , Hydraulic Machines, Metropolitian Company book companyLimited
2. Yunus A.Cengel, John M.Cimbala (2006), Fluid Mechanics– Fundamental andApplications, Tata McGraw-Hill Publishing Co. Ltd.

SEMESTER	**IV**					
YEAR	**II**					
COURSE CODE	**20ME2404**					
TITLE OF THE COURSE	**MANUFACTURING PROCESS**					
SCHEME OF Instruction	Lecture Hours	Tutorial Hours	Practical Hours	Seminar/Projects Hours	Total Hours	Credits
	3	-	**2**	**-**	**70**	**4**

COURSE OBJECTIVES:

Theory component:

- To emphasize the importance of manufacturing sciences in the day-to-day life, and tostudy the basic manufacturing processes.
- To have a broad knowledge on casting process for a given product.
- To understand the importance of metal forming process.
- To understand basic manufacturing processes like casting and welding process.
- To introduce the concepts of powder metallurgy in manufacturing process.
- To identify, discuss, and analyse the manufacturing processes for processing ofplastics.
- To impart knowledge and skills to use tools, machines, equipment, and measuring instruments
- To provide knowledge of various casting process in manufacturing.
- To impart knowledge of joining process used in manufacturing.

COURSE OUTCOMES:

CO No.	**Outcomes**	**Bloom's Taxonomy Level**
CO1	Explain significance and engineering applications ofvarious casting processes	L1
CO2	Interpret foundry practices like pattern, mold and coremaking required for Casting process	L2
CO3	Differentiate various metal forming processes such asHot and Cold Working, Rolling, Forging, Extrusion and Drawing Processes	L2
CO4	Choose appropriate joining processes for a givenapplication	L3
CO5	Construct different types components using casting,welding and smithy shop	L3
CO6	Explain working principle and engineering applicationsof various manufacturing processes.	L1

COURSE CONTENT:	
MODULE 1	**08Hrs**
CASTINGPROCESS	

05 hrs

Casting- Introduction, Advantages and applications; Principle of casting processes – Sand casting, Centrifugal casting, pressure die casting, Investment casting, stir casting, solidification of casting, Gating-Principles, requirements and types, Riser – Function, types, design, Defects in castings. Patterns – Types, making, materials and allowances.

MODULE 2	**08Hrs**

METAL FORMING

Hot working & cold working, plastic deformation, yield criteria, strain hardening, recovery, recrystallization and grain growth. Rolling types & process, drawing types, sheet forming types & process, Extrusion process types, Forging Processes- classification & types- Power forging, Impression die forging, press forging, upset forging, defects in forging.

MODULE 3	**10Hrs**

WELDING PROCESS

Welding process: Classification, morphology of fusion weld, working principle, Fusion welding: Arc welding- Gas Metal Arc Welding (MIG), Gas Tungsten Arc Welding (TIG), Shielded Metal Arc Welding (SMAW), plasma arc welding, oxyfuel gas welding, Resistance welding- spot, seam, projection, Solid state welding: Friction, friction stir welding, ultrasonic welding, forge welding, electromagnetic pulse welding, hot isostatic pressure welding, Laser welding, Electron beam welding, thermit welding.

MODULE 4	**08Hrs**

POWDER METALLURGY

Introduction & applications, basic steps, methods of manufacturing powders- Physical, Chemical, Mechanical & Nano powder production methods, mixing of powders, compaction- Pressure less and pressure compaction, explosive compaction, sintering methods, post sintering process, Defects in Powder metallurgy, Characteristics and testing of Metal Powders.

MODULE 5	**08Hrs**

PROCESSING OF PLASTICS

Classification of Polymers, Forms of raw plastic material, Types and characteristics of plastics, methods of processing plastics, moulding of thermoplastics – working principles and applications, compression moulding, Transfer Moulding, blow moulding, rotational moulding, Film blowing, Thermoforming.

List of Laboratory/Practical Experiments activities to be conducted (if any) : 28Hrs

1. **Foundry shop:** Testing of Moulding sand and Core sand - Tensile Strength Test for Core Sand, Compression Test of Molding Sand, Shear Test of Moulding Sand, Permeability Test, Grain Fineness Test, Clay Content Test, Moisture Content Test, Mould Hardness Test, Foundry Model- Preparation of green sand moulds using two

molding boxes kept ready for pouring- Using patterns (Single piece pattern and Split pattern) & without patterns =
2. **Forging Operations:** Involving upsetting, drawing and bending operations, Simple exercises involving the fabrication of square & hexagonal bolts.
3. **Welding shop:** Gas welding & Arc Welding
4. **Powder Metallurgy:** To perform powder compaction of different metal powder by hydraulic press & study the mechanism of sintering (Demo)
5. Industrial Visit- Report making

TEXT BOOKS:

1. P.N. Rao. Manufacturing Technology: Foundry, Forming and Welding, McGrawHill Publication, 5th Edition. (2018)
2. Mikell P. Groover, Fundamentals of Modern Manufacturing: Materials, Processes,and Systems, 7th Edition, John Wiley & Sons, Inc, New Jersey. (2019)

REFERENCES:

1. Amitabha Ghosh and Asok Kumar Malik (2010), Manufacturing Science, AffiliatedEast-West Press Ltd.
2. J. T. Black and Ronald A. Kohser (2019) De Garmos Materials and Processes in Manufacturing, John Wiley & Sons, Inc, New York.

20VP201 Engineering Drawing - 1 Credit		
Note: • First angle projection to be followed • Instructions relevant to various drawings may be given along with appropriate demonstration, before assigning drawing practice to the students.		
Unit-I	**Introduction**: Fundamentals,Drawing Instruments and their uses, BIS conventions, Lettering, Dimensioning, line conventions,scaling, symbols, fits & tolerances	2 Hrs.
Unit-II	**Theory of Projections:**Types of projections, sketching practice of pictorial view from objects, exercise on missing surfaces and views, Identification of surfaces on drawn views & object drawn.	3 Hrs.
Unit-III	**Geometric construction & Curves:**Drawing of parallel &, perpendicular lines, Construction of polygons & solid objects – Cube, Cone, Prism, Pyramid, Frustum of Cone with dimensions, Methods of line segment&bisecting, Engineering Curves-Ellipse, parabola, hyperbola **Projection of Points:** Projections of points located in same quadrant and different quadrants	3 Hrs.
Unit-IV	**Projection of Lines:** Projection of straight lines inclined to both the principal planes – Determination of true lengths and true inclinations by rotating line method.	3 Hrs.
Unit-V	**Projection of planes:** Projectionofplanesinclinedtoboth the principal planes by change of positionmethod.	4 Hrs.
Notes: BVoC - PMT program is skill-intensive program. Although credits are specified for each courses, the general intent is that hands-on exercises that enhance skills related to the theoretical input shall have to be assigned to students. In general, skill portion be and theory portion are integrated in each course. For example: the skill based components that are assignments, field visit learning, self study, lab practice and the like are integrated with theoretical inputs		

Text Book(s)

1. Gopalakrishna, K. R. (2005) Engineering Graphics, 32nd edition, Subash Publishers Bangalore, India
2. Surjit Singh (2014), A text book of engineering drawing, Dhanpat Rai & Co, India

Reference(s)

1. Basant Agarwal and Agarwal C.M., (2008), Engineering Drawing, Tata McGraw Hill Publishing Company Limited, NewDelhi.
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar Publishing House, Gujarat, India

Objectives:

- To create awareness and emphasize the need for Engineeringdrawing
- To follow basic drawing standards andconventions
- To understand the principles of geometrical objects, curves and constructmanually
- To understand the concepts of orthographic projections
- To construct orthographic projection of points, lines and planes

Course Outcomes:

After undergoing this course students will be able to:

- Explain usage of instruments, dimensioning & tolerances, conventions and standards related to workingdrawings
- Construct points, lines and planes using orthographic projections principles

- Read and apply engineering drawing for different application in the field of work.

20VP202 **Occupational Health & Safety - 4 Credits**		
Unit-I	**Principles of Industrial Hygiene:** Introduction - Introduction to Industrial Hygiene - Standards and Guidelines and Ethical Code of Conduct - Industrial Hygiene Concepts - Work environment - Objectives of Occupational Hygiene - Levels of contaminants TLVs and its types - (ACGIH) -BEIs **Recognition of Health Hazards:**Potential health hazards, air contaminants - Physical Hazard at Workplaces: Thermal Stress Chemical Hazards at Workplaces: Biological Hazards Workplaces ErgonomicHazards Workplaces	15 Hrs.
Unit-II	**Evaluation:** Basic Toxicology Exposure Assessment Concepts Air Sampling for Particulate Matter Air Sampling for Gases and Vapors Microbial Sampling **Control:** Hierarchy of Controls Principles of Ventilation Personal Protective Equipment and Other Control Options	15 Hrs.
Unit-III	**Occupational Diseases:** Characteristics of occupational and other work related diseases - Concepts in Occupational Health - **Physical Hazards at workplace** - Thermal Stress - Cold Stress - Vibrations - Radiation **Chemical Hazards:** Gases - Vapors - Metals - Organic Solvents, Dust - Silicosis - Asbestosis, Pesticides - Occupational Infections - Occupational Dermatitis - Reproductive Effects - Behavioural Psychosomatic Disorders - Cardiac Health Disease - CNS Effects - Functions of an Occupational Health Service	15 Hrs.
Unit-IV	Occupational Safety: Occupational safety and accident prevention, Basic concepts and definitions - Occupational accidents - Causes of accidents and injuries - Prevention and control of occupational accidents - Basic First Aid Practices	15 Hrs.
Unit-V	**Occupational Ergonomics: A multidiscipline science - common causes of work accidents caused by human errors -** Ergonomic Hazards, Ergonomic Guidelines, Ergonomic injuries and their classification - Reporting (proactive and early), Ergonomic Risk Factors - Use of anthropometric data Indian Factories Act - Hazardous Processes - Permissible - Health, Safety and Welfare Provisions	15 Hrs.
Notes: BVoC - PMT program is skill-intensive program. Although credits are specified for each courses, the general intent is that hands-on exercises that enhance skills related to the theoretical input shall have to be assigned to students. In general, skill portion be and theory portion are integrated in each course. For example: the skill based components that are assignments, field visit learning, self study, lab practice and the like are integrated with theoretical inputs		

Gist of the Course

Occupational safety and health is a discipline with a broad scope involving three major fields – Occupational Safety, Occupational Health and Industrial Hygiene.

- **Occupational safety** deals with understanding the causes of accidents at work. Ways to prevent unsafe act and unsafe conditions in any workplace. Safety at work discusses concepts on good housekeeping, proper materials handling and storage, machine safety, electrical safety, fire prevention and control, safety inspection, and accident investigation.

    - **Occupational health** is a broad concept which explains how the different hazards. Risks at work may cause an illness and emphasizes that health programs are essential in controlling work-related and/or occupational diseases. Industrial hygiene discusses the identification, evaluation, and control of

- **Industrial Hygiene** is a discipline dealing with the study of physical, chemical, biological and ergonomic hazards.

Reference Books:

Web Links

1. Occupational Health and Safety Books PDF (Updated SEP 2020) (free-safety-training.com) https://www.free-safety-training.com/product/occupational-health-and-safety-books-pdf/
2. Principles of Industrial Hygiene : Lecture Materials (jhsph.edu)http://ocw.jhsph.edu/index.cfm/go/viewCourse/course/PrinciplesIndustrialHygiene/coursePage/lectureNotes/
3. http://www.oshc.dole.gov.ph/images/OSHTrainingAnnouncement/BOSH-Manual_Narrative-Handout.pdf

Course Objectives:

The Occupational Health and Safety Course has the following objectives in deliberating, discussing and understanding the principles and practice:

- To maintain the health and safety of employees in a manufacturing facility
- To prevent the unfavorable effects on health caused by working conditions
- To become familiar to occupational environment of needs of workers.
- To consider the issues relating to industrial safety, occupational medicine, industrial hygiene, training & education.
- To be conversant with regulations and laws under Indian Factories Act

Course Outcome: At the end of the course students will be able to:

- Interpret and apply work environment contaminant standards, legislative requirements and best practices in a variety of workplaces.
- Apply risk management principles to anticipate, identify, evaluate and control physical, chemical, biological and psychosocial hazards.
- Collect, manage, and interpret information and data to identify trends and issues in the workplace.
- Discuss the implications of exposures, thermal stress, cold stress, chemical, biological hazards at workplaces.
- Design, support, and evaluate health and safety programs and implement procedures using project management principles and processes appropriate to the task.

Pharma Manufacturing Operations - 4 Credits		
Unit-I	**Dosage Forms** Definition, need for dosage forms, classification of dosage forms. Definition and introduction- Tablets, capsules, powders, granules, snuffs, dentifrice, insufflations, dusting powder, emulsion, suspension, syrups, solutions, liniments, lotions, elixirs, linctus, ointments, pastes, creams and suppositories.	10Hrs.
Unit-II	**Pharmaceutical calculation** Introduction, weight and measures, measurement systems- Imperial system, Metric system, Avoirdupois system, Apothecaries system. Calculations involving percentage solutions, proof spirit and isotonic solutions.	10 Hrs.
Unit-III	**Size reduction and Separation** **Size reduction-** Definition, objectives, mechanisms, factors affecting size reduction. Hammer mill, cutter mill and ball mill. **Size separation-** Definition, objectives, mechanisms and applications of size separation. Sieve shaker and cyclone separator.	15 Hrs.
Unit-IV	**Mixing** Definition, factors affecting mixing, applications, mechanisms of mixing. Planetary mixer and Double cone blender	10 Hrs.
Unit-V	**Drying and Evaporation** **Drying-** Definition, objectives, mechanisms, applications and rate of drying curve. Tray dryer, spray dryer and fluidized bed dryer. **Evaporation**- Definition, objectives, factors influencing evaporation and applications. Horizontal tube evaporator and multiple effect evaporator.	15 Hrs.
Notes: BVoC - PMT program is skill-intensive program. Although credits are specified for each courses, the general intent is that hands-on exercises that enhance skills related to the theoretical input shall have to be assigned to students. In general, skill portion be and theory portion are integrated in each course. For example: the skill based components that are assignments, field visit learning, self study, lab practice and the like are integrated with theoretical inputs		

Reference Books

1. Ansel's Pharmaceutical Dosage Form and Drug Delivery System, Lippincott Williams and Walkins, New Delhi.

2. Lachman/Lieberman's Theory and Practice of Industrial Pharmacy, CBS Publishers & Distributors Pvt Ltd.

3. Carter S.J., Cooper and Gunn's-Dispensing for Pharmaceutical Students, CBS publishers, New Delhi.

4. Carter S.J., Cooper and Gunn's. Tutorial Pharmacy, CBS Publications, New Delhi.

5. C.V.S. Subrahmanyam, J. ThimmaSetty, Sarasija Suresh, V. Kusum Devi. Pharmaceutical Engineering (Principles and Practice). Vallabh Prakashan, Delhi.

Course Objective

1. Introduction to various pharmaceutical dosage forms.
2. To study the various pharma operations involved in the manufacturing of dosage forms.

Course Outcome

1. The students will be able to have an understanding about operations of the pharmaceutical industry.
2. The students will have an overview of basic skills involved in pharmaceutical operations.
3. The students will have knowledge on various pharmaceuticaldosage forms.

Suggested Student Activities

1. Visit library to refer the text books, reference books and manuals.
2. Explain various pharmaceutical operations, their mechanisms, advantages and disadvantages.
3. Quiz on various pharmaceutical operations.
4. Quiz on various pharmaceutical dosage forms.
5. Prepare chart of classification of various dosage forms.

20VP204 Pharmaceutical Chemistry - 3 Credits		
Unit-I	Impurities in pharmaceutical substances: History of Pharmacopoeia, Sources and types of impurities, principle involved in the limit test for Chloride, Sulphate, Iron, Arsenic, Lead and Heavy metals, modified limit test for Chloride and Sulphate. To Carry out limit tests for Chloride, Sulphate, Iron, Arsenic, Lead and Heavy metals.	9 Hrs.
Unit-II	Study of Monograph analysis of Bentonite, Dried Aluminium Hydroxide Gel, Calcium gluconate, Magnesium Hydroxide, Ferrous sulphate, Sodium carbonate and copper sulphate. To Carry out Identification tests for the above compounds.	6 Hrs.
Unit-III	Methods of expressing concentration like Molarity and Normality. Primary and secondary standards. Preparation and standardization of various solutions Like Oxalic acid, sodium hydroxide, hydrochloric acid, sodium thiosulphate, Sodium Carbonate, potassium permanganate and Cerric ammonium Sulphate.	10 Hrs.
Unit-IV	Acid base Titrations and complexometric titrations: Theories of acid base indicators, classification of acid base titrations and theory involved in titrations of strong, weak, and very weak acids and bases, neutralization curves. To carry out assay of Ammonium chloride by acid base Titration. Assay of calcium gluconate by Complexometric titration.	10 Hrs.
Unit-V	Non aqueous titration and redox Titrations. Principles and techniques. To carry out titration of Copper sulphate by Iodometry, Hydrogen peroxide by Permanganometry and estimation of Sodium Benzoate by Non Aqueous Titration.	10 Hrs.
Notes: BVoC - PMT program is skill-intensive program. Although credits are specified for each courses, the general intent is that hands-on exercises that enhance skills related to the theoretical input shall have to be assigned to students. In general, skill portion be and theory portion are integrated in each course. For example: the skill based components that are assignments, field visit learning, self study, lab practice and the like are integrated with theoretical inputs		

Reference Books:

1. A.H. Beckett & J.B. Stenlake's, Practical Pharmaceutical Chemistry Vol I & II, Stahlone, Press of University of London.
2. A.I. Vogel, Text Book of Quantitative Inorganic analysis
3. Bentley and Driver's Textbook of Pharmaceutical Chemistry.
4. Indian Pharmacopoeia.
5. M.L Schroff, Inorganic Pharmaceutical Chemistry

Course Objectives:

(1) To know the sources of impurities and methods to determine the impurities in Pharmaceuticals.
(2) To understand the monograph analysis of some Pharmaceutical compounds as per Indian Pharmacopoeia.
(3) To understand the principles of Volumetric analysis like acid base titration, Non aqueous titrations and Redox Titrations.

Course Outcome:

(1) Upon completion of the course the student shall be able to understand the types of impurities in Pharmaceuticals and shall be able to carry out limit tests for impurities as per requirements of Indian Pharmacopoeia.
(2) The student will be able to learn the Information for a drug (or class of related drugs) such as the kinds and amounts of ingredients it may contain, the conditions and limitations for which it may be offered, directions for use, warnings, and other information that its labeling must contain and will be able to perform the identification tests of some pharmaceutical compounds.
(3) The student shall be able to learn methods of expressing concentrations, preparation of tandard solutions and techniques of acid base, Non Aqueous titrations, Redox Titrations and Complexometric titrations.

Suggested Student Activities

1. Student visits Library to refer the Text books, reference books and manuals.
2. Quiz on expression of concentrations
3. Prepare chart of classification of Organic compounds
4. Prepare chart of Monograph analysis of I.P Compounds.
5. Make charts about different titrimetric methods.

20VP301	**Engineering Design**	**1 Credit - 13 hours**
Unit-I	Introduction: Fundamentals, Drawing standard - dimensioning,Lines, Introduction to orthographic & perspective projection. Construction of rectangles, circles, arc, ellipse and parabola	3 Hrs.
Unit-II	Construction of Tangent and Normal at any point on these curves,spline, use of constraints and sketch detailing and editing	2 Hrs.
Unit-III	Construction of Solids: Prisms, pyramids, cone, cylinder usingextrude and revolve operations	3 Hrs.
Unit-IV	Construction of complex solid structures using loft, rib and weboperations, creation of multiple planes	3 Hrs.
Unit-V	Assembly of parts, creation of sections, animations of the modelsand demonstration of 3d printing	2 Hrs.

Course Objectives:

- Introduce students to a discipline of design
- Create hand sketches & generate designs
- Understand the significance of Team Work and roles of individuals within a team.
- To understand the principles of geometrical curves and construct manually
- To learn using professional software for construction of geometry
- To develop the lateral surfaces of solids
- To create simple engineering 3D components and assembly

Course Outcomes:

- To build 3D part model using Autodesk Fusion 360
- Apply the design thinking principles and recognize the significance of innovation
- Identify usage of instruments, dimensioning & tolerances, conventions and standardsrelated to working drawings
- Construct geometries of planes and solids
- Develop section of solids for different planes of inclination
- Create associative models at the component and assembly levels for product design
- Develop many creative ideas through design criteria & brainstorming sessions

2.5 Text Book References

1. C. L. Dym and Patrick Little, Engineering Design- A Project Based Introduction, JohnWiley, 1995.
2. Gopalakrishna, K. R. and Sudheer Gopala Krishna (2015). "Computer Aided Engineering Drawing", Subash Publishers, Bangalore, India.
3.

References

1. Tim Brown, Change by Design: How Design Thinking Transforms Organizations andInspires Innovation (Harper Business, 2009)
2. Dhananjay A.J, (2018). "Engineering Drawing with Introduction to AutoCAD", TataMcGraw-Hill Publishing Company Ltd.

20VP302: **Pharmaceutics-I**		**4 Credits: 52 Hrs.**
Unit-I	**History of Pharmaceutics:** Events leading to the formation ofpharmaceutical society of Great Britain **Development of profession of pharmacy:** Pharmaceutical industry inIndia	8 Hrs.
Unit-II	**Origin & Development of the pharmacopoeia** – IP/BP/USP **Dosage forms:** Introduction to dosage form & routes of administration	12 Hrs.
Unit-III	**Dosage form design:** Biopharmaceutical consideration **Alternate system of medicine**: Introduction to Ayurvedic &Homeopathic formulations.	12 Hrs.
Unit-IV	**GALENICALS:** Introduction, size reduction, **General properties of drug constituents** – **Solvents** used in extraction of drugs, **Processes** used for extraction (infusion, decoction, maceration,& modifications, percolation, hot extraction & modifications).	12 Hrs.
Unit-V	**Equipment** used for large scale extractions. Study of official extracts	8 Hrs.
Notes: BVoC - PMT program is skill-intensive program. Although credits are specified for each courses, the general intent is that hands-on exercises that enhance skills related to the theoretical input shall have to be assigned to students. In general, skill portion be (50%ofcredits) and theory portion (50% of credits) for each course. For example, if a course has 2 credits, 1 credit (13 hours) will be for theoretical inputs and 1credit will be for skill based components that are assignments, field visit learning, self study and the like.		

Course Objectives: This course will discuss the following aspects of pharmaceutical dosage forms

1. to understand the history of pharmaceutics and development of systematic pharmacopeia
2. To understand dosage and design of formulations
3. To get exposed to equipment of large scale manufacture and extractions with processes

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

1. Describe biopharmaceuticals and discuss pharmacopeias
2. Explain different solvents commonly utilized in pharmaceutical manufacture
3. Discuss about processes involved in extractions on a large scale using solvents
4. Have proficiency on Pharmaceutical Formulations

References:

1 Howard C. Ansel, Nicholas G. Popovich, Lord V. Alien, Pharmaceutical Dosage Form And DrugDelivery Systems 6th , 1995 B.I.Waverly Pvt.Ltd.,New Delhi

2 David B.Troy, Remington-The Science And Practice Of Pharmacy (Vol.1& 2) 21st, 2006Lippincott Williams & Wilkins

3 J.W. Cooper, Colin Gunn, Tutorial Pharmacy 4th, 1950 Sir Isaac Pitman & Sons Ltd., London

4 Michael E. Aulton, Pharmaceutics: The Science Of Dosage Form Design 1998 Churchill-Livingstone

20VP303: **Biochemistry and Clinical Pathology**		**3 Credits; 39 Hrs.**
Unit-I	**Introduction to biochemistry** **Proteins –** Brief chemistry and role of proteins, polypeptidesand amino acids, classification, Qualitative tests, Biological value, Deficiency diseases.	10 Hrs.
Unit-II	**Carbohydrates –** Brief chemistry and role of Carbohydrates, Classification, qualitative tests, Diseases related to carbohydratemetabolism. **Lipids –** Brief chemistry and role of Lipids, Classification,qualitative tests. Diseases related to lipids metabolism	10 Hrs.
Unit-III	**Vitamins and Coenzymes –** Brief chemistry and role ofVitamins and Coenzymes. **Minerals –** Role of minerals and water in life processes.	8Hrs.
Unit-IV	**Enzymes –** Brief concept of enzymic action, Factors affecting it.Therapeutic and pharmaceutical importance.	5 Hrs.
Unit-V	**Metabolism –** Brief concept of normal and abnormalmetabolism of proteins, carbohydrates and lipids.	6 Hrs.
Notes: BVoC - PMT program is skill-intensive program. Although credits are specified for each courses, the general intent is that hands-on exercises that enhance skills related tothe theoretical input shall have to be assigned to students. In general, skill portion be (50%of credits) and theory portion (50% of credits) for each course. For example, if a course has 2 credits, 1 credit (13 hours) will be for theoretical inputs and 1 credit will be for skill based components that are assignments, field visit learning,self study and the like.		

Course Objectives:

- To gain the understanding of the molecular levels of the chemical process associated withliving cells.
- To provide biochemical facts and the principles to understand the metabolism of nutrientmolecules in physiological and pathological conditions.
- To understand abnormal metabolism of proteins, carbohydrates and fats

Course Outcomes:

- Understand the significance of Biochemistry and describe the chemistry of carbohydrates,lipids, proteins, and amino acids
- Discuss the enzymes, their importance in the design of new drugs, therapeutic applications.
- Explain the importance of minerals and role of water in biological processes.
- Explain metabolism of nutrient molecules and apply knowledge and skills associated withclinical pathology

Text Books:

- M. R. Chaudhari, Y. A. Kulkarni, S. B. Gokhale, Pragati Books Pvt., Ltd., 2008 Biochemistry and Clinical Pathology
- Rahul Lovhare. Rageeb Md. Usman, Sunil P Pawar, Textbook of Biochemistry and ClinicalPathology, 9781543343496
- Milind J. Umekar , N. R. Kotagale , R. T. Lohiya, A Text Book Of Biochemistry & Clinical

Pathology, Career Publication, ISBN13: 9788188739349

20VP304: **Community Pharmacy**	**39 Hours 3 Credits**

Unit-I	**Concept of health –** Definition of physical health, mental health,social health, spiritual health determinants of health, indicators of health, concept of disease, natural history of diseases, the diseaseagents, concept of prevention of diseases.	5 Hrs.
Unit-II	**Nutrition and health –** Classification of foods requirements, diseaseinduced due to deficiency of proteins, Vitamins and minerals- treatment and prevention.	6 Hrs.
Unit-III	**Environment and health –** Water borne diseases control-medicalentomology, arthropod borne diseases and their control, rodents, animals and diseases. **Fundamental principles of microbiology** – classification of microbes, isolation, and staining techniques of organisms of commondiseases.	8 Hrs.
Unit-IV	**Communicable diseases –** Causative agents, modes of transmissionand prevention. **a) Respiratory infections –** Chicken pox, measles. Influenza,diphtheria, whooping cough and tuberculosis. **b) Intestinal infections –** Poliomyelitis. Hepatitis. Cholera. Typhoid,Food poisoning, Hookworm infection. **c) Arthropod borne infections –** plague, Malaria, Filariasis. **d) Surface infections –** Rabies, Trachoma, Tetanus, Leprosy. **e) Sexually transmitted diseases –** Syphilis. Gonorrhoea. AIDS.	10 Hrs.
Unit-V	**Non-communicable diseases –** Causative agents, prevention, care andcontrol; Cancer, Diabetes, Blindness, Cardiovascular diseases. **Epidemiology –** Its scope, methods, uses, and dynamics of disease transmission, immunity and immunization: Immunological products and their dose schedule. Principles of disease control and prevention, hospital acquired infection, prevention and control. Disinfection, types of disinfection, disinfection procedures, for faeces, urine, sputum, room linen, dead-bodies, instruments	10 Hrs.
Notes: BVoC - PMT program is skill-intensive program. Although credits are specified for each courses, the general intent is that hands-on exercises that enhance skills related to the theoretical input shall have to be assigned to students. In general, skill portion be (50%of credits) and theory portion (50% of credits) for each course. For example, if a course has 2 credits, 1 credit (13 hours) will be for theoretical inputs and 1 credit will be for skill-based components that are assignments, field visit learning, self-study and the like.		

Course Objectives:

- To understand meaning of wellbeing physically, mentally, socially and spiritually
- To learn the importance of environmental health and nutrition
- To learn about various communicable diseases, the vectors and their transmission
- To lean the principles of epidemiology and non-communicable diseases

Course Outcomes:

- Discuss indicators of health, concept of disease, natural history of diseases, the disease agents
- Able to Classify nutrients, diseases due to deficiency of proteins, vitamins and minerals-
- Describe Water borne, diseases caused by rodents and animals and their control
- Demonstrate communicable and non-communicable diseases and discuss epidemiology of adisease

Text Books:

- Jon Waterfield, Community Pharmacy Handbook, Pharmaceutical Press 2008, ISBN0853697167
- Paul Rutter, Community Pharmacy, Pub.: Elsevier Health Services, 2011, ISBN:9780729580793

20VP305: **Technical Communication**		**3 Credits; 39Hours**
Unit-I	**Basics of Technical Communication:** Importance of TechnicalCommunication; Objectives and Characteristics of Technical Communication; Communication Cycle; Levels of Communication	7 Hrs.
Unit-II	**Listening Skills:** Meaning and art of listening; listening and empathy in communication; Why don't we listen (reasons forpoor listening); Poor listening habits; Qualities of a good listener; Active versus passive listening; Barriers for effectivelistening; tips for effective listening	8 Hrs.
Unit-III	**Reading:** Purpose of reading; Intensive, extensive and criticalreading **Effective Speaking:** Confidence, clarity and fluency; Rate,volume, pitch , pause; Barriers to speaking; Public speaking	8 Hrs.
Unit-IV	**Effective Presentation Strategies:** Planning, Tips for creating an impact on audience; Modes of delivery: Extemporaneous; Impromptu; Controlling nervousness and stage fright; Effectiveslides preparation skills	8 Hrs.
Unit-V	**Technical Writing:** Importance, characteristics; Audience recognition and analysis; Techniques for good technical writing	8 Hrs.
Notes: BVoC - PMT program is skill-intensive program. Although credits are specified for each courses, the general intent is that hands-on exercises that enhance skills related tothe theoretical input shall have to be assigned to students. In general, skill portion be (50%of credits) and theory portion (50% of credits) for each course. For example, if a course has 2 credits, 1 credit (13 hours) will be for theoretical inputs and 1 credit will be for skill based components that are assignments, field visit learning,self study and the like.		

Course Objectives:

- To know the importance and basics of technical communication
- To learn reading and practice effective speaking
- To understand effective presentations and prepare presentations
- To familiarize with techniques of good technical writing

Course Outcomes:

- Demonstrate basic technical communication skills
- Prepare and present to different audiences
- Able to write effectively and perform in written and oral communication

Text Books

- Meenakshi Raman, Sangeeta Sharma, Technical Communication- Principles andPractice, 3rd Ed. Oxford University Press, 2015
- Steve Mandel, Effective Presentation Skills, 2000, Course Learning ThomsonLearning

COURSE CODE : 17VT311
TITLE OF THE COURSE : CONSTITUTION AND ETHICS
L: T/A: P: C : 0: 0: 0 : 0
COURSE OBJECTIVES:
The objective of this course is to enable students:
1. To provide basic information about Indian constitution.
2. To identify individual role and ethical responsibility towards society.
3. To understand human rights and its implications
COURSE OUTCOMES:
Students after the completion of this course will be able to:
1. Have general knowledge and legal literacy and thereby to take up competitive
Examinations
2. Understand state and central policies, fundamental duties
3. Understand Electoral Process, special provisions
4. Understand powers and functions of Municipalities, Panchayats and Cooperative
Societies.
5. Understand Engineering ethics and responsibilities of Engineers.
6. Have awareness about basic human rights in India
Module-I
Introduction to the Constitution of India, The Making of the Constitution and Salient
features of the Constitution, Preamble to the Indian Constitution Fundamental Rights &
its limitations.
Module-II
Directive Principles of State Policy & Relevance of Directive Principles State Policy
Fundamental Duties, Union Executives – President, Prime Minister Parliament Supreme
Court of India.
Module-III
State Executives – Governor Chief Minister, State Legislature High Court of State,
Electoral Process in India, Amendment Procedures, 42nd, 44th, 74th, 76th, 86th &91st
Amendments.
Module-IV
Special Provision for SC & ST Special Provision for Women, Children & Backward Classes
Emergency Provisions, Human Rights –Meaning and Definitions, Legislation Specific
Themes in Human Rights- Working of National Human Rights Commission in India,
Powers and functions of Municipalities, Panchyats and Co - Operative Societies
Module-V

Scope & Aims of Engineering Ethics, Responsibility of Engineers
Impediments to
Responsibility, Risks, Safety and liability of Engineers, Honesty, Integrity &
Reliability in
Engineering

Text Book

1. Durga Das Basu 'Introduction to the Constitution of India' (Students Edn.)
Prentice
Hall EEE – 2001
2. 'Engineering Ethics' by Charles E Haries, Michael. S Pritchard and Michael J
Robins
Thompson Asia, 2003
3. Constitution of India & Professional Ethics by Raman & Yaji

Reference Books

1. 'An Introduction to the Constitution of India' by M V Pylee, Vikas
Publishing. 2002
2. Engineering Ethics _ by M Govindarajan, S Natarajan, V S Senthail Kumar,
Prentice Hall
of IndiaPvt Ltd. New Delhi, 2004
3. Brij Kishore Sharma,**"Introduction to the Constitution of India"**, PHI
Learning Pvt.
Ltd., New Delhi, 2011.
4. Latest Publications of Indian Institute of Human Rights, New Delhi.

COURSE CODE : 19MDE5064
TITLE OF THE COURSE : MICRO ELECTRICAL MECHANICAL SYSTEMS (MEMS)L: T/A: P: C : 3:0: 2: 4

COURSE OBJECTIVES:

1. To learn dynamics and modelling of micro-systems
2. Understanding design and analysis of micro and Nano system applications
3. Develop experience on microsystems for sensors and actuators applications
4. To learn and characterize technology for MEMS

COURSE OUTCOMES:

1. Gain knowledge and have knowledge on state-of-the-art MEMS techniques for Microsystems
2. Have an ability to identify, formulate and solve problems in the field of micro electrical systems.

Introduction - Micro Electro-Mechanical Systems, Ultra Precision Engineering, Micro-sensors; Micro-actuators; Microelectronics Fabrication; Micromachining; Mechanical MEMS; Thermal MEMS : MOEMS; Magnetic MEMS; RF MEMS; Micro-fluidic Systems; Bio and Chemo – Devices; MEMS Packages and Design Considerations; Micro-Instrumentation.

Mechanical Sensors and Actuators- Principles of Sensing and Actuation; Beam and Cantilever; Micro plates; Capacitive Effects; Piezoelectric material as Sensing and Actuating Elements; Strain Measurement; Pressure measurement; Flow Measurement using Integrated Paddle – Cantilever Structure; Pressure Measurement by Microphone; Shear mode Piezo actuator; Gripping Piezo actuator; Inchworm Technology.

Thermal and Fluidic Micro Sensors and Actuators - Thermal sensors, Electrical Sensors, Chemical and Biosensors Electromagnetic and Thermal micro actuation, Mechanical design of micro actuators, examples, Micro Fluidic systems, Fluid actuation methods, micro valves, micro pumps, micro motors-Micro actuator systems : Ink-Jet printer heads, Micro-mirror TV Projector.

MEMS- Design and Analysis- Basic concepts of design of MEMS devices and processes, Design for fabrication, Other design considerations, Analysis of MEMS devices, FEM and Multiphysics analysis, Modelling and simulation.

MEMS- Characterization- Technologies for MEMS characterization, Scanning Probe Microscopy (SPM): Atomic Force Microscopy (AFM), Scanning tunnelling microscopy (STM), Magnetic Force Microscopy, Scanning Electron Microscope, Laser Doppler vibrometer, Electronic Speckle Interference Pattern technology (ESPI).

TEXT BOOKS:

1. Rai-Choudhury P. MEMS and MOEMS Technology and Applications, PHI Learning Private Limited, 2009.
2. Stephen D. Senturia, Microsystem Design, Springer, 2001
3. Marc Madou, Fundamentals of Microfabrication, Taylor & Francis Group, 2002
4. Gregory Kovacs, Micromachined Transducers Sourcebook, McGraw Hill, 1998

REFERENCE BOOKS:

1. Bao, M.H., Micromechanical Transducers- Pressure sensors, accelerometers, and gyroscopes, Handbook, Elsevier, 2000.
2. Nadim Maluf, An Introduction to Micro electromechanical Systems Engineering, Artech House Publishers, 2000.
3. Stephen D. Senturia, Microsystems Design, Kluwer Academic Publishers, New York, November 2000

COURSE CODE : 19MDE5070
TITLE OF THE COURSE : RELIABILITY AND FAILURE
ANALYSISL: T/A: P: C : 3:0: 2: 4

COURSE OBJECTIVES:

1. To understand the course and is planned for those interested in reliability and failure analysis of experiments.
2. To allows and increase efficiency of experimentation, and reveal the essential reliability nature of a process.
3. In particular, risk analysis and techniques are learnt more.

COURSE OUTCOMES:

1. The course will examine how to avoid failure design and analyze the data for success.
2. The program will provide more knowledge in terms of fault tree analysis, system reliability and applications.

Reliability Definition- Introduction, Definition of reliability, Failure data, Mean failure rate, mean time to failure((MTTF), Mean time between failures (MTBF), Graphical plots, Four important points, MTTF in terms of failure density, Generalization, Reliability in terms of Hazard rate and failure density, Mean time to failure in integral form. Hazard Models- Constant hazard, Linearly-increasing hazard, The weibull model, On density function and distribution function, Distribution function and reliability analysis, Choice of distribution, Expected value, Standard deviation and variance, Theorems concerning expectation and variance.

System Reliability- Series configuration, Parallel configuration, Mixed configurations, Application to specific hazard models, Anr-out-of-n structure, Methods of solving complex systems, cut and tie set method, Systems not reducible to Mixed configurations, Mean time to failure of systems, Logic diagrams, Markov models, Markov Graphs, Systems Subjected to Probability Laws. Reliability Improvement-Improvement of Components, Redundancy, Element Redundancy, Unit Redundancy, Standby Redundancy, Optimization, Reliability- cost Trade- off.

Fault-Tree Analysis and other Techniques- Fault-Tree Analysis, Fault-Tree Construction, Calculation of Reliability from fault tree, Tie-Set and cut -set, Use of Boolean Algebra, Basic operations, Truth Tables, De Morgan's Theorem, Application to reliability analysis, Probability Calculations.

Maintainabilty and Availabity- Maintainability, Availability (Qualitative Aspects) System Downtime, Availabity, Reliability and Maintainability trade-off, Instantaneous repair rate, Mean time to repair (MTTR), Reliability and Availability functions. Reliability Allocation and Applications- Reliability Allocation for a Series System, Applications, Marine power plant, Computer System, Nuclear Power Plants, General Complex Systems, Failure Modes and Effects Analysis (FMEA).

Risk analysis- Definition and measurement of risk - risk analysis techniques - risk reduction resources - industrial safety and risk assessment.

TEXT BOOKS:

1. Modarres, Reliability and Risk analysis, Mara Dekker Inc., 1993
2. New Juran, J.M and Gryna, F.M, Quality Planning and Analysis - Tata Mc Graw Hill publishing Company Ltd. 1982, Delhi, India.

REFERENCE BOOKS:

1. Halpern, Seigmund, The Assurances Sciences, Prentice Hall International, New Jersey, U.S.A. 1978
2. Blanchard, Bejamin S. Logistics Engineering and Management, Prentice HallInternational, New Jersey, U.S.A. 1986.

SEM/YEAR : V SEM

COURSE CODE :

16ME303 TITLE OF THE COURSE :

COMPOSITESL: T/A:P: C : 3 :0 : 0 : 3

TOTAL HOURS 44

COURSE LEARNING OBJECTIVES

1. To develop the fundamentals of composite materials for high performance structures
2. To learn how composite materials achieve properties of strength, weight ratiosand durability in engineering components design.
3. To interpret the mechanical properties of the composite in specific applications.

COURSE OUTCOMES

1. Understand the fundamental properties, applications of composite materials
2. Understanding the function of fiber and matrix materials used in composites.
3. Understanding the role of lamina and their arrangement in a laminate.

MODULE I

Introduction to Composites 08L Hrs

Fundamentals of composites - need for composites, classification, types of matrices and fibers polymer matrix composites, metal matrix composites, ceramic matrix composites,applications of composites.

MODULE II

Macro Mechanics of a Lamina 09L Hrs

Hooke's law for different types of materials, elastic constants, independent constants fororthotropic material, two - dimensional relationship of compliance and stiffness matrix. Hooke's law for two-dimensional angle lamina, engineering constants - stress-strain relations for lamina of arbitrary orientation.

MODULE III

Micromechanics of Composites 08L Hrs

Introduction, rule of mixture, volume and weight fraction of fiber and matrix, density and void fraction in composites, longitudinal modulus and stiffness, transverse modulus, in- plane shear modulus.

MODULE IV

Stresses and Fracture Modes of a Composite 09L Hrs

Inter-laminar stresses and edge effects. Bending stress of laminated beams. Tensile and compressive strength of unidirectional fiber composites, fracture modes in composites: Single and multiple fracture, de-bonding, fiber pullout and de-lamination failure, fatigue of laminate composite.

MODULE V

Fabrication and Testing of Composites **10L Hrs**

Open and closed mould processing, hand lay-up techniques, bag moulding and filament winding. pultrusion, resin transfer moulding (RTM), thermoforming, injection moulding,measurement of basic composite properties: tensile test, compressive test, shear test, interlaminar shear test, flexure test. Nondestructive testing method - ultrasonic inspection, radiography, acoustic emission and acoustic ultrasonic method.

Text Books

1. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science,Chapman and Hall, London, England, 1st edition, 1994.
2. Chawla K.K., Composite Materials, Springer-Verlag, 1987

Reference Books

1. Jones, R.M., Mechanics of Composite Materials, McGraw Hill Co., 1967.
2. J. N. Reddy, Mechanics of Laminated Composite Plates & Shells, CRC Press, 2nd Ed,2004.
3. P.C. Mallik, Fibre Reinforced Composites, Marcel Decker, 1993.

SEM/YEAR : V SEM
COURSE CODE : 16ME304
TITLE OF THE COURSE : DYNAMICS OF
MACHINERYL: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS 44

COURSE LEARNING OBJECTIVES

1. To enable students to do static & dynamic force analysis of mechanical machinesand mechanisms.
2. To enable students to analyse gyroscopes, flywheels and governors to solve important engineering problems.
3. To enable students to understand how balancing is carried out theoretically insingle and multi-cylinder engines (for rotating and reciprocating masses).

COURSE OUTCOMES

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

1. Understand static and dynamic forces acting on different mechanisms.
2. Understand the principle of power transmission in belt drives.
3. Calculate the effect of gyroscopic couples on ships, aeroplanes, two wheelers andbalance different types of engines.
4. Apply the concepts of sensitiveness and isochronism's in the analysis of governors.

MODULE I

Static & Dynamic Force Analysis **10L Hrs**

Introduction, Static equilibrium. Equilibrium of two and three force members, memberswith two forces and torque, free body diagrams. Principle of virtual work, static forceanalysis of four bar mechanism and slider-crank mechanism with and without friction Dynamic Force Analysis: D'Alembert's principle, inertia force, inertia torque. Dynamicforce analysis of four-bar mechanism and slider crank mechanism.

MODULE II

Power Transmission **07L Hrs**

Friction and Belt Drives: Definitions, types of friction, laws of friction, friction in pivot andcollar bearings.
Belt drives: Flat belt drives. Ratio of belt tensions, centrifugal tension, power transmitted.

MODULE III

Balancing of Rotating Masses **08L Hrs**

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

MODULE IV

Balancing of Reciprocating Masses **09L Hrs**Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine (primary & secondary forces), V-type engine; radial engine – directand reverse crank method.

MODULE V

Governor & Gyroscope **10L Hrs**

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

Gyroscope: Vectorial representation of angular motion. Gyroscopic couple, effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers.

Text Books:

1. Sadhu Singh, Theory of Machines, Pearson Education. 2nd edition, 2007.
2. Rattan S.S. Theory of Machines, Tata McGraw Hill Publishing Company Ltd., NewDelhi, 3rd Edition, 2009.

Reference Books:

1. J.J. Uicker, G.R. Pennock, J.E. Shigley, Theory of Machines & Mechanisms, Oxford3rd Ed. 2009

A.G.Ambekar, Mechanism and Machine Theory, PHI, 2007

SEM/YEAR : **V SEM**
COURSE CODE : **16ME305**
TITLE OF THE COURSE : **MANUFACTURE TECHNOLOGY-II**
L: T/A:P: C : **3 :0 : 0 : 3**
TOTAL HOURS **44**

COURSE LEARNING OBJECTIVES

1. Understand and appreciate the importance of basic principles of traditional manufacturing and material removal processes.
2. To enable students understand processes like casting, forging, rolling etc.
3. Understand the application of those principles in practice.
4. To have a basic knowledge on non-conventional machining processes.

COURSE OUTCOMES

After successful completion of the course, the students should be able to

1. Understand the various machining processes such as turning, drilling, milling andgrinding.
2. Understand the principle of non-traditional machining processes.
3. Identify and suggest correct manufacturing process for particular application andfundamentals of CNC machining.

MODULE 1

Metal Casting Processes **08L Hrs**

Fundamentals of metal casting, Fluidity of molten metal, solidification time, sand casting, shell mold casting, investment casting, plaster mold casting, ceramic mold casting, die casting, centrifugal casting, melting practice and furnaces, defects in castings, testing andinspection of castings.

MODULE II

Metal Forming Processes **08L Hrs**

Cold and hot working, Rolling – Forging – Extrusion – Drawing – Sheet metal forming processes – High Energy Rate Forming processes: Explosive forming, Electro hydraulic forming – Electromagnetic forming.

MODULE III

Conventional Machining Processes **10L Hrs** Turning: Classification, tool layout, driving mechanisms of lathe and different operationson lathe.

Drilling machines: Classification, constructional features, drilling & related operations. Milling: Classification, constructional features, milling operations, up milling and downmilling concepts, various milling operations indexing: simple, compound, differential andangular indexing calculations.

Grinding: Types of abrasives, grain size, bonding process, grade and structure of grinding wheels, grinding wheel types. Classification, constructional features of grinding machines.

MODULE IV

Non-Conventional Machining Processes and Introduction to Computer Numerical Control Machines **09L Hrs**

Classification, Principle of abrasive jet machining, water jet machining, ultrasonic machining, electric discharge machining, electro chemical machining, laser beam machining - process characteristics – applications, advantages and disadvantages.

Introduction to computer numerical control machines- principle of operation, coordinate systems. Basics of manual part programming methods.

MODULE V

Additive Manufacturing **09L Hrs**

Development of additive manufacturing systems, virtual prototyping, rapid tooling. Classification of additive manufacturing processes-benefits- applications, introduction on liquid and solid based additive manufacturing systems, powder based additive manufacturing systems, three-dimensional printing.

Text Books

1. Kalpak Jain, Manufacturing Engineering & Technology, Addison Wesley,1997
2. Poul De Garmo, J.T.Black, R.A.Kosher, Materials and Processes in Manufacturing, Prentice Hall of India, 1997.
3. Gibson, I., Rosen, D.W. and Stucker, B., Additive Manufacturing Methodologies: RapidPrototyping to Direct Digital Manufacturing, Springer, 2010.

Reference Books

1. R.K.Jain, Production Technology, Khanna Publishers, 2001.
2. R.K.Gupta,Production Technology, Sathya Prakashan, 2010.

SEM/YEAR : VI SEM
COURSE CODE : 16ME309
TITLE OF THE COURSE : MECHATRONICS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS 44

COURSE LEARNING OBJECTIVES

1. To understand principles and operation of different mechatronic components used in engineering applications.
2. To know different types of sensors, transducers and control systems
3. Students are able to acquaint themselves with the application of mechatronics systems in various engineering applications.

COURSE OUTCOMES

1. Ability to appreciate the mechatronic system design and applications.
2. Theoretical and practical aspects of computer interfacing, real time data acquisition and control.
3. Able to apply mechatronics skills and principles for designing mechanical components and systems.

MODULE I

Introduction to Mechatronics **08 Hrs**

Definition of Mechatronics, key elements of a mechatronic system, measurement systems, mechatronics in manufacturing, products, and design, mechatronics design process, design parameters, traditional and mechatronics designs, advanced approaches in mechatronics, data conversion devices, electrical components, resistive circuits, sensors, micro sensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs.

MODULE II

Sensors and Transducers **08 Hrs**

Sensors and Transducers**:** performance terminology, displacement, position and proximity, velocity and motion, force, fluid pressure, liquid flow, liquid level, temperature, light sensors, selection of sensors, inputting data by switches.

MODULE III

Control and Drives **10 Hrs**

Control devices**:** Electro hydraulic control devices, electro pneumatic proportional controls. Drives: Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems. Rotational drives–Pneumatic motors: Continuous and limited rotation – Hydraulic motor: continuous and limited rotation –Motion convertors, fixed ratio, invariant motion profile, variators.

MODULE IV

Basic System models **10 Hrs**

Mathematical models, mechanical system building blocks, electrical system building blocks, fluid system building blocks, thermal system building blocks, engineering systems, rotational-translational systems, electro mechanical systems, hydraulic mechanical systems, hydraulic systems- flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps.

MODULE V

Data Acquisition **8 Hrs**

Introduction**:** Quantizing theory, analog-to-digital conversion, digital-to-analog conversion, virtual instrumentation, data acquisition, and control. Practical considerations-introduction to LabVIEW programming, USB 6009 data acquisition card.

Text Books

1. Bolton, W., Mechatronics - Electronic Control Systems in Mechanical and Electrical Engineering, 2nd Edition, Addison Wesly Longman Ltd., 1999.
2. Gupta, Virtual Instrumentation Using Lab view, 2nd Edition, Tata McGraw-Hill Education, 2010
3. Brian Morriss, Automated Manufacturing Systems - Actuators Controls, Sensors and Robotics, McGraw Hill International Edition, 1995.

Reference Books

1. G. S. Hegde, Mechatronics Jones and Bartlett Publishers, 2010.
2. Georg pelz, Mechatronic Systems: Modeling and Simulation, with HDL's, John wiley and sons, Ltd, 2003
3. Gary Jonson, Labview Graphical Programming, Second Edition, McGraw Hill, New York, 1997

SEM/YEAR : VI SEM
COURSE CODE : 16ME333
TITLE OF THE COURSE : ADVANCED MACHINING PROCESS
L: T/A:P: C : 3 :0 : 0 : 3
TOTAL HOURS 44

Course Learning Objectives

1. To make awareness among students on recent trends in advanced machining processes
2. To understand the knowledge of advanced machining over conventional machining
3. To learn the advantages of advanced machining and applications

Course Outcomes

Students should be able to

1. Select appropriate advanced materials processes for a given product or component recognizing material, size, precision, and surface quality requirements.
2. Discuss the working of unconventional machining processes.

MODULE I

Mechanical Machining 07L Hrs

Introduction: Need and classification of nontraditional machining processes – material removal in traditional and nontraditional machining processes - considerations in process selection

Ultrasonic Machining: Introduction, ultrasonic machining system- mechanics of cutting, parametric analysis- process capabilities, applications.

Water Jet Machining: Principle, process variables, advantages and disadvantages, applications, Abrasive water jet machining- pumping system- abrasive feed system- abrasive water jet nozzle, catcher, process variables, applications.

MODULE II

Electric Discharge Machining 09L Hrs

Electric Discharge Machining: Mechanism of material removal, dielectric fluid, electrode materials, spark erosion generators, electrode feed system, material removal rate, process parameters– characteristics of spark eroded surfaces, advantages and disadvantages, applications.

Die-sinker EDM: Principle, electrolytes, advantages and disadvantages, applications.

Wire EDM: Principle, wire feed system – advantages and disadvantages, applications.

Electro-chemical discharge machining: Working principle, process parameters, advantages and disadvantages, applications

MODULE III

Chemical Machining 09L Hrs

Chemical Machining: Fundamentals, principle, classification, selection of etchant, Chemical milling – engraving – blanking – drilling – trepanning.Advantages and

disadvantages – applications.
Electro Chemical Machining: Electro chemical process, electrolytes, properties, material removal rate, tool materials, tool feed systems, design of electrolyte flow – process

variables, advantages – disadvantages, applications, Electro chemical grinding, honing, deburring, turning.

MODULE IV

Electron Beam Machining **09L Hrs**

Electron Beam Machining: Principle, generation – control of electron beam – advantages

–disadvantages, applications.

Laser Beam Machining: Principle, solid – gas laser methods, applications, thermal features, advantages – disadvantages, applications.

Ion Beam Machining: Equipment, process characteristics, advantages, disadvantages, applications, plasma arc machining, principle, gas mixture, types of torches, process parameters, advantages, disadvantages, applications.

Plasma Arc Machining - Metal removal mechanism, process parameters, process characteristics, types of torches, applications.

MODULE V

Abrasive Machining **10L Hrs**

Abrasive Jet Machining (AJM): Introduction, abrasive jet machining setup, abrasive feeder, machining chamber, AJM nozzle, parametric analysis - stand-off-distance - abrasive flow rate - nozzle pressure - mixing ratio, applications, Abrasive Flow Machining (AFM) - working principle, AFM system, process variables, process performance and applications.

Magnetic Abrasive Finishing (MAF) - working principle, MAF system, material removal and surface finish, process variables and applications.

Chemo-Mechanical Polishing: working principle, material removal and surface finish andapplications.

Text Books

1. Vijay.K. Jain, Advanced Machining Processes, Allied Publishers Pvt. Ltd., New Delhi,
2. Pandey P.C., and Shan H.S. Modern Machining Processes, Tata McGraw-Hill, NewDelhi,

Reference Books

1. Mc Geough, Advanced Methods of Machining, Chapman and Hall, London, 1998.
2. Paul De Garmo, Black, J.T.and Ronald.A.Kohser, Material and Processes in Manufacturing, Prentice Hall of India Pvt. Ltd., New Delhi (8th Edition), 2001: ISBN –81-
3. Benedict. G.F. Nontraditional Manufacturing Processes, Marcel Dekker Inc., NewYork,

SEMESTER/YEAR : V SEM/III YEAR
COURSE CODE : 16ME339
TITLE OF THE COURSE : FUNDAMENTALS OF ARTIFICIAL INTELLIGENCE &MACHINE LEARNING
L: T/A: P: C : : 3 :0 :0 :3

COURSE OBJECTIVES:

The objective of this course is to present the fundamental principles and practices of AI and ML to address the real-world mechanical engineering problems. The course is designed to develop a basic understanding of problem solving, knowledge representation, reasoning and learning methods of AI. design and implement a typical AI problem to be solved Using Machine Learning Techniques

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

1. Comprehend the ideas of AI and problem-solving techniques
2. Understand the representation of knowledge and reasoning
3. Hand-on experience on Python Programming
4. Realize Machine Learning techniques in supervised and unsupervised learning
5. Recognise the importance of data science, AI & ML in Mechanical Engineering

Module I 08 Hrs

INTRODUCTION

Introduction to AI - History – Applications, Intelligent Agents: Characteristics and types, Problem Solving with AI: AI models-Data Acquisition and Learning Aspects in AI.

Python programming for AI.

Module II 10 Hrs

PROBLEM SOLVING WITH AI

Problem Solving Process - Formulating Problems - Problem Types and Characteristics- Problem Analysis and Representation. Problem Solving Search Strategies: Uninformed Search Methods - BFS - Greedy BFS-Uniform cost search- DFS - Depth limited search - Iterative deepening, Informed Search Methods- A* Search, Branch-and-Bound Search - Optimal search algorithm A* and iterative deepening A*, Local Search Algorithms and Optimization Problems - Hill climbing and Simulated Annealing

Module III 12 Hrs

KNOWLEDGE REPRESENTATION & DECISION MAKING

Knowledge organization, manipulation and acquisition. Knowledge Representation: Logic-Propositional-Predicate-Unification- Representing Knowledge using Rules -

Forward Chaining -Backward Chaining - Resolution – Semantic Networks- FrameSystems - Inference - Types of Reasoning

PLANNING & DECISION MAKING

Introduction to Planning - Plan Space Planning - Planning Graph and Graph Plan - Practical Planning and Acting - Sequential Decision Problems - Making Complex Decisions

Module IV 08 Hrs

MACHINE LEARNING

Introduction to Machine Learning – Unsupervised learning, Supervised learning: Decision Trees - Linear Regression - Support Vector Machines - Bayesian Networks - Neural Networks - Reinforcement Learning - Deep Learning: a brief overview

Module V 10 Hrs

AI & ML APPLICATIONS

AI applications - Language Models - Vision or Robotics - Self driving car: a brief overview. Machine learning application using python for mechanical engineering datasets: mechanical vibrations - heat transfer - fluid mechanics - manufacturingprocess.

AI Ethics: Humans vs Robots, Robustness & transparency of AI systems, Accountability, Privacy & Human-AI interaction

TEXT BOOKS:

1. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
2. Nagy Z. Artificial Intelligence and Machine Learning Fundamentals: Develop real- world applications powered by the latest AI advances. Packt Publishing Ltd;2018.

REFERENCES:

1. David L. Poole, Alan K. Mackworth, Artificial Intelligence: Foundations ofComputational Agents, Cambridge University Press, 2010.
2. Nils J. Nilsson, the Quest for Artificial Intelligence, Cambridge University Press,2009.
3. Richard E Neapolitan; Xia Jiang Artificial Intelligence: With an Introduction toMachine Learning, Chapman and Hall/CRC Press, 2018.

SEM/YEAR : V SEM
COURSE CODE : 16ME371
TITLE OF THE COURSE : HEAT TRANSFER LABORATORY
L: T/A:P: C : 0 :0 : 4 : 2

COURSE LEARNING OBJECTIVES

Upon completion of this Laboratory, students can be able to

1. To understand the modes of heat transfer.
2. To apply the basic laws of heat transfer.
3. To gain insights into operational ranges, behavioural trends and shortcomings across different heat transfer equipment's.

COURSE OUTCOMES

1. Ability to understand industrial application of heat transfer.
2. Ability to understand the use of different heat exchangers and their applications.

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS
Record Note = 10 marks
Conduction of experiments= 10 marks
Internal Assessment = 20 marks
Total = 40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure = 10 marks
Tabulation and Formulae = 10 marks
Conduction of Experiment and Calculation = 20 marks
Graph and Result = 10 marks
Viva Voce = 10 marks
Total = 60 marks

LIST OF EXPERIMENTS

1. Determination of thermal conductivity of metal rod.
2. Determination of thermal conductivity of insulating powder.
3. Determination of thermal conductivity of composite wall.
4. Determination of heat transfer coefficient in natural convection.
5. Determination of heat transfer coefficient in forced convection.
6. Determination of temperature distribution, fin efficiency in natural / forced Convection.
7. Determination of emissivity of a test surface.
8. Determination of emissive power of black body using Stefan's Boltzmann's constant.
9. Determination of effectiveness and logarithmic mean temperature difference in parallel flow and counter flow heat exchanger.

10. Study of pool boiling phenomenon and determination of critical heat flux.
11. Determination of equivalent thermal conductivity of heat pipe.
12. Experiment on transient conduction heat transfer.

SEM/YEAR : **V SEM**
COURSE CODE : **16ME372**
TITLE OF THE COURSE : **FOUNDRY AND FORGING LABORATORY**
L: T/A:P: C : **0 :0 : 4 : 2**

COURSE LEARNING OBJECTIVES

Upon completion of this laboratory, students can be able to

1. Understand the different components of foundry and forging tools used in industry.
2. Understand the different proportions of mould ingredients, preparation of sand systems, selection of parting line, placement of pattern, ramming of sand around pattern, preparation of mould, visual inspection of mould, hardness of mould at different locations, closing of mould.

COURSE OUTCOMES

1. This course is intended to serve as a bridge between the study of the basic principles of metal foundry and their application in the producing parts.
2. To understand metal forming process that involves mechanical forces.

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	= 10 marks
Conduction of experiments	= 10 marks
Internal Assessment	= 20 marks
Total	= 40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

LIST OF EXPERIMENTS

1. Use of foundry tools and other equipment, preparation of moulds using two moulding boxes with or without patterns. (Split pattern, Match plate pattern and Core boxes).
2. Preparation of one casting (Aluminium or cast iron-demonstration only).
3. Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
4. Permeability test
5. Core hardness & Mould hardness tests.
6. Sieve Analysis to find grain fineness number of base sand
7. Clay content determination in base sand
8. Calculation of length of the raw material required to do the model, preparing minimum three forged models involving upsetting, drawing and bending operations manually using hammers.
9. Out of these three models, at least one model is to be prepared by using power hammer

SEM/YEAR : **VI SEM**
COURSE CODE : **16ME373**
TITLE OF THE COURSE : **DESIGN ENGINEERING LABORATORY**
L: T/A:P: C : **0 :0 : 4 : 2**

COURSE LEARNING OBJECTIVES

1. To enable students to analyse gyroscopes, flywheels and governors to solve important engineering problems.
2. To enable students to understand how balancing is carried out practically.
3. To enable students to do the Photo-elastic stress analysis.
4. To enable students to understand how vibration test is carried out practically.

COURSE OUTCOMES

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

1. Analyze gyroscopes, flywheels and governors to solve important engineering problems.
2. Understandhow balancing is carried out practically.
3. Perform the Photo-elastic stress analysis.
4. Carry out vibration test practically.

PART - A

1. Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2. Balancing of rotating masses.
3. Determination of critical speed of a rotating shaft.
4. Determination of Fringe constant of Photo-elastic material using.
    a) Circular disc subjected to diametral compression.
    b) Pure bending specimen (four point bending)
5. Determination of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression, 2D crane hook.

PART – B

1. Determination of equilibrium speed, sensitiveness, power and effort of Porter/Prowel /Hartnel Governor (only one or more).
2. Determination of pressure distribution in journal bearing.
3. Determination of principal stresses and strains in a member subjected to combined loading using strain rosettes.
4. Determination of stresses in curved beam using strain gauge.
5. Experiments on Gyroscope.

Text Books:

1. Sadhu Singh, Theory of Machines, Pearson Education. 2nd edition, 2007.
2. Rattan S.S. Theory of Machines, Tata McGraw Hill Publishing Company Ltd., New Delhi, 3rd Edition, 2009.

Reference Books:

1. J.J. Uicker, G.R. Pennock, J.E. Shigley "Theory of Machines & Mechanisms", Oxford 3rd Ed. 2009
2. A.G.Ambekar, Mechanism and Machine Theory, PHI, 2007

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	= 10 marks
Conduction of experiments	= 10 marks
Internal Assessment	= 20 marks
Total	= 40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

SEM/YEAR : VI SEM
COURSE CODE : 16ME374
TITLE OF THE COURSE : MODELING, ANALYSIS AND SIMULATION LABORATORY
L: T/A:P: C : 0 :0 : 4 : 2

COURSE LEARNING OBJECTIVES

1. To equip students to use FEA package and modelling stress analysis of bars, trusses & beams.
2. To equip students to carry out thermal and dynamic analysis using FEA package.
3. To equip students to use CAM Software for solving Mechanical Engineering problems
4. To introduce them to solving application oriented problems using FEA & CAM

COURSE OUTCOMES

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

1. Apply the concepts of finite element method to solve structural, dynamic and thermal problems using FEA package.
2. Use CAM software and functions in their codes.
3. Perform matrix related operations and employ conditional and looping statements.
4. Create user-defined functions and solve linear algebraic equations of first order and second order differential equations.

PART - A

Study of a FEA package and modeling stress analysis of

a. Bars of constant cross section area, tapered cross section area and stepped bar 6 Hours
b. Trusses – (Minimum 2 exercises) 3 Hours
c. Beams – Simply supported, cantilever, beams with UDL, beams with varying load etc (Minimum 6 exercises) 09 Hours

PART - B

a) Stress analysis of a rectangular plate with a circular hole 3 Hours
b) Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 4 exercises) 9 Hours
c) Dynamic analysis
    1) Fixed – fixed beam for natural frequency determination
    2) Bar subjected to forcing function
    3) Fixed – fixed beam subjected to forcing function 8 Hours

PART - C

Study of a CAM package and generating CNC Codes.

a) CNC part programming using CAM packages- Simulation of Turning, Drilling, Milling operations.
b) 3 typical simulations to be carried out using simulation packages like Master - CAM, or any equivalent software.

c) Basic knowledge of CNC Codes.

Text Books:

1. A First Course in the Finite Element Method, Daryl L Logan, Thomason, Third Edition

Reference Books:

1. Fundaments of FEM, Hutton – McGraw Hill, 2004
2. Finite Element Analysis, George R. Buchanan, Schaum Series.

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	= 10 marks
Conduction of experiments	= 10 marks
Internal Assessment	= 20 marks
Total	= 40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

SEM/YEAR : **VI SEM**
COURSE CODE : **16ME375**
TITLE OF THE COURSE : **ENERGY CONVERSION LABORATORY**
L: T/A:P: C : **0 :0 : 4 : 2**

COURSE LEARNING OBJECTIVES

The main objective of this Course is to help students

1. To carry out tests to investigate the performance of internal combustion engines
2. Find out fire and flash point of different combustion fuels
3. To impart how to measure important performance parameters of experimental investigation on internal combustion engines

COURSE OUTCOMES

Student will be able to

1. Understand IC engine, its components and selection of fuels
2. Analyse carburettor& ignition system to be suitable for CI and SI engines
3. Draw heat balance sheet for different types of internal combustion engines.

UNIVERSITY PRACTICAL EXAMINATION

Allotment of Marks

Internal Assessment = 40 marks
Practical Examination = 60 marks

INTERNAL ASSESSMENT [40 Marks]

SPLIT UP OF INTERNAL MARKS

Record Note	= 10 marks
Conduction of experiments	= 10 marks
Internal Assessment	= 20 marks
Total	= 40 marks

UNIVERSITY EXAMINATION : Split up of Practical Examination Marks

Aim and Procedure	= 10 marks
Tabulation and Formulae	= 10 marks
Conduction of Experiment and Calculation	= 20 marks
Graph and Result	= 10 marks
Viva Voce	= 10 marks
Total	= 60 marks

LIST OF EXPERIMENTS

1. Determination of Flash point and Fire point of lubricating oil using Abel, Pensky and Marten's (closed) / Cleavland's (Open Cup) Apparatus.
2. Determination of Calorific value of solid, liquid and gaseous fuels.
3. Determination of Viscosity of lubricating oil using Redwoods, Saybolt and Torsion Viscometers.
4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/2 stroke).
5. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal Efficiencies, Volumetric efficiency, Mechanical efficiency, SFC, FP, A-F Ratio, heat balance sheet for
   (a) Four stroke Diesel Engine
   (b) Four stroke Petrol Engine
   (c) Multi Cylinder Diesel/Petrol Engine, (Morse test)

(d) Two stroke Petrol Engine
(e) Variable Compression Ratio I.C. Engine.

SEMESTER **VIII**
COURSE CODE **: 16ME431**
TITLE OF THE COURSE **: AUTOMATION IN MANUFACTURING**
L: T/A:P: C **: 3 : 0 : 0 : 3**

Course Objectives

1. To provide a comprehensive introduction to industrial automation
2. To introduce the modeling methods for the performance analysis and design of automation systems
3. To provide comprehensive introduction of various automation systems and related techniques for programming and system analysis.

Course Outcomes Students will be able to

1. Appreciate the relevance of industrial automation.
2. Analyze the performance of automated production lines and automated assembly systems.
3. Design and draw the functional and logic circuits for the programming of the control elements for automation.
4. Understand the role of computer-numerical control and robotics in programmable automation and estimate the effectiveness of programmable automation using cycle time analysis
5. Become familiar with the tools and techniques for automated inspection.

Module I: Introduction **08L Hrs**

Automation in production systems. Fixed, flexible and programmable automation. Principles, reasons and strategies for automation.
Automated systems – elements, functions, levels of automation. Continuous Vs discrete control.
Product/production relationships, Production concepts and mathematical models, Costs of manufacturing operations.

Module II : Automated Production Lines and Automated Assembly **08L Hrs**

Fundamentals of automated production lines. Applications. Analysis of transfer lines with no internal storage. Analysis of storage lines with storage buffers.
Fundamentals of automated assembly systems. Design for automated assembly.

Module III: Control Elements for Automation **10L Hrs**

Sensors, Sensors position and velocity feedback. Actuators. Servo control. ADC, DAC. Control of electro-hydraulic and electro-pneumatic systems – Fluid-power symbols andfluid-power control circuits.
Programmable logic controllers – architecture - Ladder logic diagrams.

Module IV: Programmable Automation **10L Hrs**

NC and CNC units – Part programming – Direct Numerical control – Adaptive control.
Robot anatomy – specifications – end effectors – applications in manufacturing.
Robot cell design and control. Robot cycle-time analysis. Flexible manufacturing systems.

Module V: Automated Material Handling and Inspection **08L Hrs**

Automated guided vehicle systems. Automated storage and retrieval systems, carousel storage, and their analysis.
Automated inspection systems: Inspection metrology and conventional methods. Coordinate measuring machine. Surface measurement. Introduction to Machine Vision and other optical methods. Non-contact and non-optical inspection techniques.

Text books

1. M. P. Groover, Automation, Production Systems, and Computer-Integrated Manufacturing, 4th Edition, Pearson, 2016.

Reference books

1. B. Benhabib, Manufacturing: Design, Production, Automation and Integration, New York: Marcel Dekker, 2003
2. Y. Altintas, Manufacturing Automation, Cambridge University Press, 2nd Edition, 2012.
3. J.A. Rehg, Introduction to Robotics in CIM Systems, 5th edition, Prentice Hall, 2003.
4. G.G. Rigatos, Intelligent Industrial Systems: Modeling, Automation and Adaptive Behavior, Information Science Reference, New York, 2010.
5. W. Bolton, Mechatronics: A Multidisciplinary Approach, 4th Edition, Pearson, 2008.
6. M.P. Groover et al., Industrial Robots: Technology, Programming and Applications, McGraw Hill, 2008.

SEMESTER **VIII**

COURSE CODE **: 16ME432**

TITLE OF THE COURSE **: ORGANIZATION BEHAVIOUR & PROFESSIONAL COMMUNICATION**

L: T/A:P: C **: 3 : 0 : 0 : 3**

Course Learning Objectives

1. To study the behaviour of individuals and groups as part of the social and technical system in the workplace.
2. To examine individual and group behaviour, communication, conflict and various management styles, motivational techniques and coordination in the work environment and apply these concepts to the development of an organization's human resources.

Course Outcomes

Upon successful completion of this course, the student will have demonstrated the ability:

1. To discuss the development of the field of organizational behaviour and explain the micro and macro approaches.
2. To analyze and compare different models used to explain individual behaviour related to motivation and rewards.
3. To identify the processes used in developing communication and resolving conflicts.

Module I: Introduction **08L Hrs**

Definition of Organization Behaviour and Historical development, Environmental context (Information Technology and Globalization, Diversity and Ethics, Design and Cultural, Reward Systems). Foundations of individual behaviour, individual differences. Ability. Attitude, Aptitude, interests. Values.

Module II : Learning and Perception **08L Hrs**

Definition, Theories of Learning, Individual Decision Making, classical conditioning, operant conditioning, social learning theory, continuous and intermittent reinforcement. Definition, Factors influencing perception, attribution theory, selective perception, projection, stereotyping, Halo effect.

Module III: Motivation **10L Hrs**

Maslow's Hierarchy of Needs theory, Mc-Gregor's theory X and Y, Hertzberg's motivation Hygiene theory, David Mc-Clelland's three needs theory, Victor Vroom's expectancy theory of motivation.

Module IV: The groups, conflict and stress management **08L Hrs**

Definition and classification of groups, Factors affecting group formation, stages of group development, Norms, Hawthorne studies, group processes, group tasks, group decision making. Definition of conflict, functional and dysfunctional conflict, stages of conflict

process. Sources of stress, fatigue and its impact on productivity. Job satisfaction, job rotation, enrichment, job enlargement and reengineering work process

Module V: Principles of Communication **10L Hrs**

Useful definitions, communication principles, communication system, role of communication in management, barriers in communication, how to overcome the barriers, rule of effective communication.

Text books

1. Organizational behavior-Afsaneh Nahavandi, Robert Denhardt, Janet Denhardt, Maria Aristigueta- SAGE publications 2015
2. Organizational behavior- Stephen Robbins and Timothy Judge

Reference books

1. Business and professional communication- Sthephen A Beebe, Timothy P Mottet
2. Organizational behaviour and Management- John Martin

SEMESTER **VIII**
COURSE CODE **: 16ME483**
TITLE OF THE COURSE **: PROJECT WORK STAGE - II**
L: T/A:P: C **: 0 : 0 : 2 : 1**

Course Learning Objective

The main objective of the Project Work is for the students to learn and experience all the major phases and processes involved in solving "real life engineering problems".

Course Outcomes

Students must have acquired:

- System integration skills
- Documentation skills
- Project management skills
- Problem solving skills

The project work shall be spread over in B.Tech VII semester and B.Tech VIII semester. The project work shall be somewhat innovative in nature, exploring the research bent of mind of the student. A project batch shall comprise of not more than four students. The project work shall be evaluated for 100 marks out of which 100 marks for internal evaluation and 100 marks for end-semester evaluation.

The Departmental Committee (DC) consists of HOD, Supervisor and two senior experts in the department. The committee monitors the progress of Project Work. The DC is constituted by the Principal on the recommendations of the department Head.

A candidate will continue the Project Work in B.TechVIII semester (Stage - II) and submit a Project report at the end of Stage - II after approval of the Departmental Committee. During Stage - II, the teams shall submit status report in addition to oral presentation before the DC. The DC shall evaluate the project for internal marks based on the progress, presentations and quality of work.

The report generally contains:

- Cover
- Title page
- Certificate(s)
- Acknowledgements
- Abstract
- Contents page
- List of figures or Tables
- Introduction
- Literature survey
- Methodology
- Results and Discussion
- Conclusion and scope of future work.
- Reference list / Bibliography

- Appendices.

Avoiding plagiarism

1. Plagiarism is taking the words, theories, or ideas of another person and passingthem off as your own.
2. Plagiarism can be copying inadvertently/advertently a passage from a book orjournal or pasting something from the internet into report without referencingthe original source.
3. Plagiarism can also result from wrong referencing.

Avoiding plagiarism

The guide/supervisor shall certify that the report is checked for plagiarism and iswithin 25% of the content.

The project work shall consist of research work done by the candidate or a comprehensive and critical review of any recent development in the subject of specialization or a detailed report of project work consisting of experimentation/numerical work, design and or development work that the candidate has executed. It is expected that students should refer national and international journals,proceedings of national and international seminars. Emphasis should be given to the introduction to the topic, literature review, and scope of the proposed work along with some preliminary work/experimentation carried out on the thesis topic. Student should submit the project work covering the content discussed above and highlighting the features of work to be carried out in the work. Student should follow standard practice ofthesis writing. At the end of successfully finishing the work he/she has to submit a detailed report and has to present for a viva–voce.

Every candidate doing B.Tech. shall be encouraged to send a paper for publication in a journal or a conference - preferably a concept paper related to their topic highlighting their contribution and the results of their work. An acknowledgement from the Supervisor for having communicated to the journal or conference shall be attached to thereport of the Project Work.

SEMESTER/YEAR : IV SEM / II YEAR
COURSE CODE : 19ENC003
TITLE OF THE COURSE : ECONOMICS FOR ENGINEERS
L: T: P: S/P: C : 02:00:00:00:02

Course Objectives

The objectives of the Course are to:

- Understand the importance of economics in engineering decisions as well as day-to-day life and identify various factors of production
- Determine production possibility curve, marginal rate of transformation and opportunity costs
- Calculate compound interest, effective interest, nominal interest and the inflation value ● Draw the cash-flow diagram of a firm, calculate their present worth and equivalent annual worth
- Describe methods to compare assets of equal and unequal lives and understand sinking fund method
- Discuss capital budgeting, payback period method, account rate of return method, benefit/cost analysis
- Discuss net present value method, internal rate of return and return on investment ● Explain replacement criteria such as deterioration, obsolescence, inadequacy and cyclic replacements
- Explain the causes, methods of computing depreciation values, and relation with Indian Income Tax act
- Calculate depreciation using various methods
- Discuss break-even analysis

Course Outcomes

After undergoing this course students will be able to:

· Explain the relevance of economics in engineering manufacturing environment. · Determine the time value of money

· Determine the present worth and equivalent annual worth of the firm's assets and investments.

· Assess the available economic alternatives using traditional and discounted cash flow methods

· Calculate the depreciation value of equipment using different methods · Perform break-even analysis for a manufacturing company

Course Content

Basic Concepts of Engineering Economics 04 hours Introduction to Engineering economics, Engineering decision makers, engineering and economics, problem solving and decision making, strategy and tactics,

factors of production, Production possibility schedule and curve, marginal rate of transformation, Concept of economic growth

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Time Value of Money 03 hours Time value of money - Simple interest, compound interest – nominal interest rate, effective interest rate, and inflation.

Present Worth and Equivalent Annual-Worth Comparisons 07 hours Present worth calculations, Equivalent Annual worth Comparison methods, Situations for Equivalent Annual worth Comparison, Consideration of asset life, comparison of assets with equal and unequal lives,

Economic Evaluations 07 hours Introduction, capital budgeting, importance of capital budgeting, Traditional and discounted cash flow methods of capital budgeting – payback period method, accounting rate of return method, profitability index, net present value method, internal rate of return, Benefit/Cost Analysis, return on investment. break-even analysis

Replacement Analysis and Depreciation 05 hours Replacement due to deterioration, obsolescence, inadequacy, Economic life for cyclic replacements, Depreciation, Causes of Depreciation, Basic methods of computing depreciation charges, Use of sinking fund method.

Text Book and References

Text Book:

1 Riggs, J., Bedworth D., & Randhawa S., (2011), **Engineering Economics,** 4th Edition, McGraw-Hill Education

2 Pindyck, R. S., & Rubinfeld, D. L. (2015), **Microeconomics,** 7th edition, Pearson Education India

References:

· Panneerselvam R, (2013), **Engineering Economics,** 2nd edition, Prentice Hall India Learning Private Limited

COURSE CODE : 19MDE5040
TITLE OF THE COURSE : SMART MATERIALS & STRUCTURESL: T/A: P: C : 3:0: 2: 4

COURSE OBJECTIVES:

This course enables understanding the concept of MEMS and Microsystems.

1. Understand the diverse technological and functional approaches and applications.
2. Provides an insight of micro sensors, actuators and micro fluidics.

COURSE OUTCOMES:

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

1. Become familiar with micro fabrication techniques
2. Assess whether using a MEMS based solution is the relevant and best approach
3. Select the most suitable manufacturing process and strategies for micro fabrication

Overview of Smart Materials, Structures and Products Technologies. Smart Materials (Physical Properties) - piezoelectric materials, materials, magneto strictive, electro strictive materials, magneto electric materials. Magneto rheological fluids, electro rheological fluids, shape memory materials, fiber-optic sensors.

Smart Sensor, Actuator and Transducer Technologies - smart sensors- accelerometers, force sensors, load cells, torque sensors, pressure sensors, microphones, impact hammers, MEMS sensors, sensor arrays smart actuators: displacement actuators, force actuators, power actuators, vibration dampers, shakers, fluidic pumps, motors smart transducers, ultrasonic transducers, sonic transducers, air transducers.

Measurement, Signal Processing, Drive and Control Techniques- quasi-static and dynamic measurement methods, signal-conditioning devices, constant voltage, constant current and pulse drive methods; calibration methods, structural dynamics and identification techniques, passive, semi-active and active control, feedback and feed forward control strategies.

Design, Analysis, Manufacturing and Applications of Engineering Smart Structures and Products - Case studies incorporating design, analysis, manufacturing and application issues involved in integrating smart materials and devices with signal processing and control capabilities to engineering smart structures and products.

Emphasis on structures, automation and precision manufacturing equipment, automotives, consumer products, sporting products, computer and telecommunications products, medical and dental tools and equipment.

TEXT BOOKS:

1. Culshaw, B., Smart Structures and Materials, Artech House, Boston, 1996.
2. Srinivasan, A. V., Smart Structures: Analysis and Design, Cambridge University Press, Cambridge; New York, 2001.

REFERENCE BOOKS:

1. Uchino, K., Piezoelectric Actuators and Ultrasonic Motors, Kluwer Academic Publishers, Boston, 1997.
2. Otsuka, K. and Wayman, C. M., Shape Memory Materials – Cambridge University Press, Cambridge; New York, 1996.
3. Gandhi, M. V. and Thompson, B.S, Smart Materials and Structures, Chapman and Hall, London; New York, 1992.

COURSE CODE : 19MDE5063
TITLE OF THE COURSE : FRACTURE MECHANICS

L: T/A: P: C : 3:0: 2: 4

COURSE OBJECTIVES:

1. To instil knowledge of advanced sensor systems.

2. To provide an application oriented approach in instrumentation.

COURSE OUTCOMES:

1. Identify the most suitable method of sensing and transduction for an application.
2. Design instrumentation and associated data acquisition system.

Basic Concepts of Measurements and characteristics of an Instrumentation System-System configuration, Problem analysis, Basic characteristics of measuring, Calibration, Generalized measurements, Zero order, First order, second order system, Dead time element.

Sensors and Transducers –Electromechanical sensors, Resistance type, Potentiometer, Strain gauge, Resistance thermometer, RTD, Inductance type, Capacitance type, Piezo Electric type.

Magnetic sensors – NMR, MRI, Fiber optic sensors, Opto electronic sensors, CCD, Digital transducers.

Analog and Digital Instrumentation - Operational Amplifiers, Signal generation, Signalprocessing, Filtering and signal analysis.

Data Acquisition, Conversion, Transmission and Processing- Signal Conditioning of the inputs – Single channel and Multichannel data acquisition, Data conversion, Multiplexers, Sample and hold circuits, Data transmission systems, Pulse code formats, Modulation techniques, Telemetry system.

TEXT BOOKS:

2. Nubert, H.K.P., Instruments Transducers, Clarendon Press, Oxford, 1963
3. Ernest O. Doebelin, Measurement System Application & Design McGraw Hill, New York, 1983.

SEMESTER/YEAR : **I SEM**
COURSE CODE : **19MDE5171**
TITLE OF THE COURSE : **DESIGN LABORATORY-I (FINITE ELEMENT SOLUTIONS)**
L: T/A: P: C : **0:0: 4: 2**

COURSE OBJECTIVES:

1. To know how to model, analyze mechanical systems using finite element analysis software
2. Learn the concepts of finite element analysis and use their skill for getting solutions
3. Develop models of mechanical systems using finite element software.

COURSE OUTCOMES:

1. Interpret the obtained results from finite element analyses software and compare with the experimental work.
2. Take note on necessary information and work on structural, thermal and dynamic analysis using finite element software

Stress analysis of rectangular plate with circular hole under 1). Uniform Tension and 2). Shear: Calculation and Plot of normalized hoop Stress at hole boundary in Infinite Plate, Modelling of plate geometry under chosen load conditions and study the effect of plate geometry. Numerical Analysis using FEA package.

Modelling: Surface modelling. Solid modelling and Assembly. Generation of Ferguson's cubic surface patches, Generation of Bezier UNISURF surface patches, Generation of Coon's patches.

Analysis of Structures: Static Analysis. Modal Analysis. Harmonic Analysis. Spectrum Analysis. Buckling Analysis, Analysis of Composites.

Students are trained in 3D Modelling and Finite Element Software such as Pro-E, SolidWorks, ANSYS, as part of the Lab exercise

SEMESTER/YEAR : **I SEM**
COURSE CODE : **19MDE5172**
TITLE OF THE COURSE : **DESIGN LABORATORY- II**
(EXPERIMENTAL STRESS ANALYSIS)
L: T/A: P: C : **0:0: 4: 2**

COURSE OBJECTIVES:

1. Prepare and to study subjects such as mechanics of materials and machines, vibration and controls, and the design of tools and machines.

2. Provide stress analysis tools for designing equipment and instrumentation studies.
3. Use and evaluate stress measurement techniques.

COURSE OUTCOMES:

1. Ability to convey information regarding designing and reporting results of experiments
2. Ability to calculate stress from experimental measurements and get familiarity with photo elastic material properties

Contact Stress Analysis of Circular Disc under diametrical compression**:** 3-D Modelling of Circular Discs with valid literature background, Experimental results on contact stress, 2D Photo Elastic Investigation; Stress analysis in Curved beam in 2D.

Experimental studies using Strain Gauge Instrumentation, 2D Photo elastic Investigation, Modelling and Numerical Analysis using FEM. Experimental Investigations using a Journal Bearing Test Rig. Stress Analysis of a Thick Walled Cylinder with specified Temperature at inner and outer Surfaces.

Preparation and calibration of Photo elastic sheets. Preparation of Photo elastic models like Discs, Beams and Columns

Stress determination for different models having regular shapes, loaded conventionally, and comparison of results with theoretical values. Measurement of strains for different shapes, by different arrangements of strain gauges.

SEMESTER/YEAR : II SEM
COURSE CODE : 19MDE5201
TITLE OF THE COURSE : ADVANCES IN MATERIAL TECHNOLOGY
L: T/A: P: C : 3: 1: 0: 4

COURSE OBJECTIVES:

1. Introduce the various aspects Ceramics, composites, MMCS
2. To learn fabrication and operational skills and applications for Composite materials
3. To have overview of surface engineering and other treatments for materials environment.

COURSE OUTCOMES:

1. Should be able to process and prepare composite materials effectively.
2. Will be able to understand the selection of materials and challenges in material sector

Introduction- Properties of Materials, Structure property relationship, Newer Materials
– Ceramics and Composite materials, Ceramics – Fine ceramics, Types of ceramics, Structure of Ceramics, Properties of Ceramics, Applications.

Composite Materials- Types – Metal matrix Composites (MMC), Ceramic Matrix Composites (CMC), Polymeric composites Structure, Properties and Applications of different composite materials.

Processing of MMC & CMC, Vacuum infiltration, squeeze casting, pressure die casting, Rheo-casting, Compo-casting, Super plastic forming

Processing of PMC-Hand Lay Up, Bag Molding Process, Autoclave molding, Compression molding, Pultrusion, Filament winding, Resin Transfer molding, Injection molding. Surface Engineering- Surface quality & integrity, concepts, Mechanical treatment, Thermal & Thermo-chemical treatment.

Thermal Spraying Processes and Applications- Vapour depositions processes and applications, Ion-treatment, Laser Treatment.

TEXT BOOKS:

1. Paul Degarmo, E. Black, J.T. and Ronald A Kohser, Materials and Processing in Manufacturing, John Wiley & Sons, 2011.
2. Minoru Taya, and Richard J. Arsenault, Metal Matrix Composites, Elsevier Science & Technology, 1989
3. Mallick, P.K. Fiber-Reinforced Composites: Materials, Manufacturing, and Design, Third Edition, CRC Press, 2007

REFERENCES BOOKS:

1. Schwartz, M.M. Composite Materials Handbook, Second Edition, McGraw Hill Higher Education, NewYork, 1995
2. Tadeusz Burakowski and Tadeusz Wierzchon, Surface Engineering of Metals:Principles, Equipment, Technologies, CRC Press, 1998

SEMESTER/YEAR : **II SEM**
COURSE CODE : **19MDE5271**
TITLE OF THE COURSE : **DESIGN LABORATORY- III (DYNAMICS LABORATORY)**
L: T/A: P: C : **0:0: 4: 2**

COURSE OBJECTIVES:

1. Understand the basic software tools for the design and implementation for systems.
2. Ability to design and conduct experiment
3. Perform several lab design experiments for structural, thermal engineering and mechanics

COURSE OUTCOMES:

1. Work independently and demonstrating the professional and ethical responsibilities.
2. Ability to design a system and required component to meet the desired needs for manufacturability, sustainability and safety.

Single edge notched beam in four point bending: Modelling of single edge notched beam in four point bending, Numerical Studies using FEA, Correlation Studies

Determination of damped natural frequency of vibration of the vibrating system with different viscous oils. Determination of steady state amplitude of a forced vibratory system. Static balancing using steel balls. Determination of the magnitude and orientation of the balancing mass in dynamic balancing. Field balancing of the thin rotors using vibration pickups. Determination of the magnitude of gyroscopic couple, angular velocity of precession and representation of vectors

Structural Analysis: FE modelling of a stiffened Panel Buckling, Bending and Modal analysis of stiffened Panels.

SEMESTER/YEAR : **II SEM**
COURSE CODE : **19MDE5272**
TITLE OF THE COURSE : **DESIGN LABORATORY- IV (SIMULATION LABORATORY)**
L: T/A: P: C : **0:0: 4: 2**

COURSE OBJECTIVES:

1. To practice skills in a safe environment and conduct an inventory of simulation technologies
2. Design and plan for implementing simulation activities
3. To develop mathematical model equations for the simulation system

COURSE OUTCOMES:

1. Ability to demonstrate the model solving ability for various operations
2. To develop model equations for the system and able to processsimulation

Numerically Calculation and MATLAB Simulation: Invariants, Principal stresses and strains with directions, Maximum shear stresses and strains and planes, Von-Misesstress, Calculate and Plot Stresses in Thick-Walled Cylinder

Modelling and Simulation of Control Systems using MATLAB; Vibration Characteristics ofa Spring Mass Damper System- Analytical Solutions, MATLAB Simulation, Correlation Studies. Torsion of Prismatic bar with Rectangular cross-section-Elastic solutions, MATLAB Simulation.

SEM/YEAR : III SEM
COURSE CODE : 16ME205
TITLE OF THE COURSE : MACHINE DRAWING
L: T/A:P: C : 1 :0 : 4 : 3
TOTAL HOURS 47

Course Learning Objectives

1. The objective of this course is to make students understand the principles and requirements of machine & production drawings.
2. To make the students understand and interpret drawings of machine components so as to prepare assembly drawings using standard CAD packages.
3. To develop the technical skills necessary to generate an engineering drawing and an engineering assembly using a modern CAD system.
4. This course will provide a way to learn how to assemble and disassemble important parts used in major mechanical engineering applications.

Course Outcomes

1. After going through this course, students shall be able to draw & understand the drawings of mechanical components and their assemblies.
2. Students can create 3D models of engineering objects, engineering drawings with different views, and an assembly of the objects that make up engineered systems, using a CAD system (e.g. AutoCAD)

Module I: Sections of Solids 08 Hrs

Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids) True shape of sections.

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.

Module II: Permanent Fastenings 08 Hrs

Riveted Joints: Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets) Common types of joints, terminology, proportions and representation; Welds: Types of welds and welded joints, edge preparation, specifications, and representation of welds on drawings

Module III: Detachable Fasteners 08 Hrs

Thread forms: Types, forms, standard, and specifications; Drawing of temporary connections; Thread terminology, sectional views of threads. 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. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.

Module IV: Keys, Joints and Couplings **08 Hrs**

Keys: Parallel key, Taper key, Feather key, Gib head key and Woodruff key, cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. Couplings: Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)

Module V: Assembly drawing **15 Hrs**

Assembly drawing with sectioning and bill of materials from given detailed drawings of assemblies.

1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Tool Head of a shaper

Text books

1. N.D. Bhat & V.M. Panchal 'Machine Drawing'
2. French, T. E., Vierch, C. J., and Foster, R. J., Engineering Drawing and Graphic Technology,14th Ed., McGraw-Hill, 1993

Reference books

1. S. Trymbaka Murthy, 'A Text Book of Computer Aided Machine Drawing', CBS Publishers, New Delhi, 2007
2. K.R. Gopala Krishna 'Machine Drawing', Subhash Publication.
3. Narayana K.L., Kannaiah, P., and Venkata Reddy K, Machine Drawing, 3rd Ed., New Age International Publishers, 2006.
4. Johan K. C., Text Book of Machine Drawing, PHI Learning Pvt., 2009

SEM/YEAR : IV SEM
COURSE CODE : 16ME208
TITLE OF THE COURSE : KINEMATICS OF MACHINES
L: T/A:P: C : 3 :0 : 2 : 4
TOTAL HOURS 52

Course Learning Objectives

1. The study of kinematics is concerned with understanding of relationships between the geometry and the motions of the parts of a machine.
2. The overall objective of this course is to learn how to analyze the motions of mechanisms, design mechanisms to give desired motions.
3. This course includes relative motion analysis, design of gears, gear trains, cams and linkages, graphical and analytical analysis of position, velocity and acceleration, clutches, brakes & dynamometers.

Course Outcomes

1. Students will be able to understand the concepts of displacement, velocity and acceleration of simple mechanism, drawing the profile of cams and its analysis, gear kinematics with gear train calculations, brakes & dynamometers.

Module I: Basics of Mechanisms **10 Hrs.**

Definitions 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.
Quick return motion Mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism. Straight line motion mechanisms. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism.

Module II: Mechanisms with Lower Pairs **10 Hrs.**

Pantograph, Straight Line Mechanisms, Approximate Straight Line Motion Mechanism: Watt's Straight mechanism, Application of Straight Line Mechanisms. Steering gears: Davis Steering gear, Ackermann Steering gear, Universal Hook's Joint. Brakes and Dynamometers: Types of brakes: Simple shoe brake, Band Brake, Band and Block brake, Internal expanding shoe brake, Dynamometer, Absorption Dynamometer: Prony brake dynamometer, Transmission Dynamometer: Epi-cyclic train dynamometer, Belt transmission dynamometer, Torsion dynamometer.

Module III: Kinematic Analysis **10 Hrs.**

Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons: Relative velocity and acceleration of particles in a common link, relative velocity and accelerations of coincident Particles on separate links- Coriolis component of acceleration. Velocity Analysis by Instantaneous Center

Method: Definition, Kennedy's Theorem, Determination of linear and angular velocity

using instantaneous center method Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism.

Module IV: Gears and Gear Trains **10 Hrs.**

Spur Gears: Gear terminology, law of gearing, Characteristics of involute action, Path of contact. Arc of contact, Contact ratio of spur, helical, bevel and worm gears, Interference in involute gears. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth. Profile Modification.

Gear Trains: Simple gear trains, Compound gear trains for large speed. Reduction, Epicyclical gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclical gear trains. Tooth load and torque calculations in epicyclical gear trains.

Module V: Cams **12 Hrs.**

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-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion

Text books

1. Theory of Machines, Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009.
2. Theory of Machines, Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi.

Reference books

1. "Theory of Machines & Mechanisms", J.J. Uicker, G.R. Pennock, J.E. Shigley. Oxford 3rd Edition, 2009.
2. Theory of Machines and Mechanisms: Joseph Edward Shigley and John Joseph Uicker, Jr. Second Edition, MGH, New York.
3. Theory of Mechanisms and Machines: Amitabha Ghosh and Ashok kumar Mallik, Third Edition Affiliated East-West Press.
4. Mechanism and Machine theory, Ambekar, PHI, 2007

SEM/YEAR : IV SEM
COURSE CODE : 16ME209
TITLE OF THE COURSE : MANUFACTURING TECHNOLOGY – I
L: T/A:P: C : 3 :0 : 0: 3
TOTAL HOURS 44

Course Learning Objectives

1. Understanding importance of cutting tool materials
2. Define the various terms related to metal cutting and recognize the types of chip formation.
3. Identify the applications of various cutting tool material, mechanism and operation of a machine tools.
4. Practical experience on various machine tools and their operations
5. Identify different arc welding processes for joining the materials and recognize the metallurgical aspects of welding.

Course Outcomes

1. Summarize basic machine tools for various machining operations
2. Analyze machining parameters on surface finish, type of operations, production and tool life
3. Interpret type of tools for suitable machining operations based on machining parameters
4. Identify machine tools, operation and other condition for industrial machining components
5. Choose correct manufacturing process for a particular engineering application.

Module I: Fundamentals of Manufacturing 08 Hrs

Manufacturing: selecting manufacturing process, global competitiveness of manufacturing costs, Classification of manufacturing, Fundamentals of materials- their behavior and manufacturing properties – Ferrous metals and alloys – Non-ferrous metals and alloys

Module II: Cutting Tool Materials 08 Hrs

Desired properties, types of cutting tool materials-HSS carbides, ceramics cutting fluids, desired properties, types and selection, machinability, factors affecting machinability.

Module III: Theory of Metal Cutting 10 Hrs

Single point cutting tool nomenclature, geometry, orthogonal and oblique cutting, mechanism of chip formation, types of chip, merchant analysis, Ernst-merchant's solution, shear angle relationship, problem of merchant's analysis, tool wear and tool failure effects of cutting parameters, tool life criteria, Taylor's tool life equation, problem on tool evaluation, heat generation in metal cutting, tool tip measurements

Module IV: Joining Processes **10 Hrs**

Metal fusion welding processes: Oxy-fuel gas welding – Arc welding processes, Consumable electrode: Shielded Metal Arc Welding (SMAW), Submerged Arc Welding (SAW), Gas Metal Arc Welding (GMAW), Electro gas welding, Electro slag welding. Non-consumable Electrode: Gas Tungsten Arc Welding (GTAW), Electron Beam Welding (EBW), and LASER Beam Welding (LBW), Solid state welding processes: Ultrasonic welding, Friction welding, Resistance welding: Spot welding, seam welding, Weld quality, welding defects.

Module V: Processing of Power metals, Ceramics and Glass **08 Hrs**

Production of metal powders: Compaction – Sintering and Finishing – Design, Considerations for powder metallurgy and Process capability – Shaping of ceramics – Forming and shaping of glass – Design considerations for ceramics and glass – Processing of superconductors.

Text books

1. Serope Kalpak Jian; Steven R. Schmid (2010), Manufacturing Engineering and Technology, 6th Edition, Publisher: Prentice Hall, ISBN-10 0-13-608158-1, ISBN- 13 978-0-13-608158-5.
2. P.N. Rao. (2009), Manufacturing Technology – Foundry, Forging and Welding, Tata McGraw Hill Publishing Company Ltd., New Delhi.

Reference books

1. M P Groover (2007), Fundamentals of Modern manufacturing (materials, processes and systems) third edition, Wiley publications, ISBN-978-0-471-74485-6, USA

SEM/YEAR : III SEM
COURSE CODE : 16ME272
TITLE OF THE COURSE : MANUFACTURING PROCESS LABORATORY
L: T/A:P: C : 0 :0 : 4: 2

Course Learning Objectives

The objective of this course is to make the student aware of

1. The basic fundamentals and mechanics of metal cutting, tool geometry, tool life and tool wear etc.
2. It will give knowledge of tool materials, tool life, tool wear, effect of lubrications and coolant used in machining operation.
3. The basic knowledge of various machine tools, classification, specification, operations of each machining processes like turning, milling, shaping, final finishing operations.

Course Outcomes

The students able learn and understand

1. The fundamental concepts and mechanics of metal cutting operations, various tool materials, various parameters affecting machining operations like feed, speed, coolant, tool life, tool wear, temperature etc.
2. The students experience the practical and theory of various machining processes. The various operations, equipment's, specifications and applications of individual machining processes etc.

LIST OF EXPERIMENTS

1. Introduction of General Purpose Machines
2. Study of Single Point Cutting Tool and Multi Point Cutting Tool
3. To Study of Mechanism in Lathe and Perform Various Operations on a Lathe Machine
4. To Study Construction, Working and Performing Operations on a Drilling Machine
5. To Study Construction and Working of Milling Machine
6. To Study Construction, Working and Perform Grinding Operation on a Grinding Machine
7. To Study Construction, Working and Perform of Shaping Operation on a Shaper Machine
8. Introduction of Computer Numerical Control Machines and Demonstration of Few Work Pieces Jobs.

SEM/YEAR : IV SEM
COURSE CODE : 16ME273
TITLE OF THE COURSE : FLUID MECHANICS AND MACHINES LABORATORY
L: T/A:P: C : 0 :0 : 4: 2

Course Learning Objectives

Upon completion of this Laboratory, students can be able to

1. Have hands on experience in flow measurements using different flow measurement device like Notch, Venturi Meter, orifice meter and also perform calculations related to losses in pipes.
2. Performance characteristics.
3. Study of Various pumps and turbines.

Course Outcomes

1. Ability to use various flow measurement equipment's
2. Ability to do performance characteristics study on different fluid machineries

LIST OF EXPERIMENTS

1. **Performance Test on Pelton Wheel Turbine** -To evaluate the constant speed and constant head characteristics and also to plot unit quantities.
2. **Characteristics Curves of Francis Turbine** -To evaluate the constant speed and constant head characteristics on Francis turbine and also to plot unit quantities.
3. **Determination of the Co-Efficient of Discharge of the Given Orifice Meter** -To determines the co-efficient of discharge for orifice meter at different flow rates.
4. **Determination of the Co- Efficient of Discharge of the Given Venturimeter** -To determine the coefficient of discharge for venturimeter at different flow rates.
5. **Co- Efficient of Discharge of the Given Notch Apparatus** -To calibrate and determine the co-efficient of discharge of notches of different shapes for different flow rates.
6. **Calculation of the Rate of Flow Using Rotameter-**To calibrate rotameter at different flow rates with actual discharge.
7. **Pipe Friction Apparatus**- i) To draw the Moody's friction factor diagrams for different diameter and material of the pipe. ii) To find and compare friction factor for different types of pipe.
8. **Loss of Head on Pipe Fittings Apparatus** -To determine and compare pressure drop across various pipe settings.
9. **Performance Test on Centrifugal Pump** -To evaluate the characteristics of centrifugal pump at various speeds, heads and flow rates, using digital power meter for measurement of input power.
10. **Performance Test on Reciprocating Pump** - To determine the flow, head, power performance characteristics of a reciprocating pump at various speeds and to

determine the characteristics with volumetric efficiency (slip).

11. **Performance Test on Gear Pump Test Rig**- To evaluate the flow, head, power performance characteristics of a gear pump at various speeds using oil as the medium of flow.

SEM/YEAR : IV SEM
COURSE CODE : 16ME274
TITLE OF THE COURSE : MEASUREMENTS LABORATORY
L: T/A:P: C : 0 :0 : 4:

Course Learning Objectives

1. The objectives of this course are to:
2. Introduce the students to the need, standards and principles of measurement.
3. Introduce the students to the principles of various mechanical elements – such as screws, threads and gears.
4. Provide the students the basics of measurements systems.
5. Focus on principles of transducers.

Course Outcomes

The purpose of this course is to provide the student with a basic understanding of the theory and practice of measurement and instrumentation. Upon completion of this course, the student should:

1. Recognize the basic elements of common measurement systems.
2. Be able to estimate the accuracy of a measurement, identify possible sources of Measurement errors.
3. Be able to operate various measurement devices / systems such as transducers, LVDT, Pressure cell, thermocouple, strain gages, etc.

LIST OF EXPERIMENTS

1. **Calibration of Micrometer** - To calibrate the given micrometer using slip gauge, draw the calibration curve and to evaluate the errors occurred.
2. **Calibration of Vernier caliper and measurement of the given component** - To calibrate and measure the given component by using Vernier caliper.
3. **Calibration of Thermocouple** - To calibrate the given T-Type Thermocouple at different temperatures.
4. **Calibration of Linear Variable Differential Transformer (LVDT)** - To calibrate the given LVDT (for the performance using Vernier height gauge.
5. **Calibration of Load Cell** - To calibrate the given Cantilever Beam type load cell.
6. **Measurements using Optical Profile Projector** – To measure the screw thread parameters of a given specimen using Optical Profile projector.
7. **Measurements using Toolmaker's Microscope** - To measure the screw thread parameters of a given specimen using Tool Maker's Microscope.
8. **Measurements of angle using Sine bar** - To determine the unknown angle of the given specimen using sine bar with the help of slip gauge.
9. **Measurements of angle using universal bevel protractor** - To determine the unknown angle of the given specimen using universal bevel protractor.

10. **Measurements of Screw thread parameters using two wire or three-wire methods** - To find the effective diameter of a given screw thread by two or three wire method.
11. **Measurements of surface roughness parameters using mechanical comparator** - To measure the various surface roughness parameters of the components using mechanical comparator (dial gauge indicator)
12. **Measurements of gear tooth profile using gear tooth Vernier caliper** - To Measure the tooth thickness of the given gear using Gear Tooth Vernier Caliper.
13. **Measurements of Vibrations -**To study the vibrations measurement, frequency, displacement, velocity & acceleration.

SEMESTER/YEAR : **I SEM**
COURSE CODE : **16MDE571**
TITLE OF THE COURSE : **DESIGN LABORATORY-I (FINITE ELEMENT SOLUTIONS)**
L: T/A: P: C : **0:0: 4: 2**

COURSE OBJECTIVES:

1. To know how to model, analyze mechanical systems using finite element analysis software
2. Learn the concepts of finite element analysis and use their skill for getting solutions
3. Develop models of mechanical systems using finite element software.

COURSE OUTCOMES:

1. Interpret the obtained results from finite element analyses software and compare with the experimental work.
2. Take note on necessary information and work on structural, thermal and dynamic analysis using finite element software

Stress analysis of rectangular plate with circular hole under 1). Uniform Tension and2). Shear: Calculation and Plot of normalized hoop Stress at hole boundary in Infinite Plate, Modelling of plate geometry under chosen load conditions and study the effect of plate geometry. Numerical Analysis using FEA package.

Modelling: Surface modelling. Solid modelling and Assembly. Generation of Ferguson's cubic surface patches, Generation of Bezier UNISURF surface patches, Generation of Coon's patches.

Analysis of Structures: Static Analysis. Modal Analysis. Harmonic Analysis. Spectrum Analysis. Buckling Analysis, Analysis of Composites.

Students are trained in 3D Modelling and Finite Element Software such as Pro-E, SolidWorks, ANSYS, as part of the Lab exercise.

SEMESTER/YEAR : **I SEM**
COURSE CODE : **16MDE572**
TITLE OF THE COURSE : **DESIGN LABORATORY- II (EXPERIMENTAL STRESS ANALYSIS)**
L: T/A: P: C : **0:0: 4: 2**

COURSE OBJECTIVES:

1. Prepare and to study subjects such as mechanics of materials and machines, vibration and controls, and the design of tools and machines.

2. Provide stress analysis tools for designing equipment and instrumentation studies.
3. Use and evaluate stress measurement techniques.

COURSE OUTCOMES:

1. Ability to convey information regarding designing and reporting resultsof experiments
2. Ability to calculate stress from experimental measurements and get familiarity with photo elastic material properties

Contact Stress Analysis of Circular Disc under diametrical compression**:** 3-D Modelling of Circular Discs with valid literature background, Experimental results on contact stress, 2D Photo Elastic Investigation; Stress analysis in Curved beam in 2D.

Experimental studies using Strain Gauge Instrumentation, 2D Photo elastic Investigation, Modelling and Numerical Analysis using FEM. Experimental Investigations using a Journal Bearing Test Rig. Stress Analysis of a Thick Walled Cylinder with specifiedTemperature at inner and outer Surfaces.

Preparation and calibration of Photo elastic sheets. Preparation of Photo elastic models like Discs, Beams and Columns

Stress determination for different models having regular shapes, loaded conventionally,and comparison of results with theoretical values. Measurement of strains for different shapes, by different arrangements of strain gauges.

SEMESTER/YEAR : III & IV SEM
COURSE CODE : 16MDE633
TITLE OF THE COURSE : DESIGN OF MATERIALS HANDLING SYSTEMSL:
T/A: P: C : 3:2: 0: 4

COURSE OBJECTIVES:

1. To expose the students with latest material handling system used in industry.
2. To reduce manufacturing cycle time, delays, damage and improveworking conditions of the systems
3. Developing tools for robot handling systems.

COURSE OUTCOMES:

At the end of this course the student should be able to understand the:

1. Basics of material handling system.
2. Various material handling equipment used in industry.
3. AGV's AS/RS system, conveyor systems.
4. Application of Robotics in material handling

Material Handling – Functions, Types, analysis, Importance & Scope, Principles, - Partfeeding device – types of material handling system – Unit material movement & Unit loads – Receiving, Shipping, in process handling – bulk handling equipment & methods.

Industrial trucks, lifting device, monorails, manipulators, conveyors, storage systems, elevators, racks, bins, pallets, cranes –Automation of material handling – mechanization of part handling.

Types of AGV's – Guidance techniques – Painted line, wire guided, vision guided method – Applications – Vehicle guidance & routing – Traffic control & safety – system management – Quantitative analysis of AGV system.

Conveyor systems – types, Quantitative relationship & analysis – Automated storage system, performance – AS/RS system – Basic components, types, controls, features, applications, Quantitative analysis – carousel storage system – applications.

General considerations in robot material handling – material transfer application – pick &

place operations – machine loading & unloading – characteristics of robot application – Robot cell design – processing, operations – Spot welding, Spray painting, Plastic moulding, forging.

TEXT BOOKS:

1. Mikell P. Groover, Automated Production system & computer integrated manufacturing –– Prentice Hall of India – 1987.
2. Govindan .K.R, Plant Layout & Material Handling – Anuradha agency – 2001.

REFERENCE BOOKS:

1. Allegeri, Theodove . H, Material Handling Principle &Practice - C.B.S. Publisher, 1987.
2. Material Handling Equipment for the Manufacturing Industry - AICTE, 1995.

SEMESTER/YEAR : III & IV SEM
COURSE CODE : 16MDE635
TITLE OF THE COURSE : NON LINEAR ANALYSISL:
T/A: P: C : 3:2: 0: 4

COURSE OBJECTIVES:

1. To introduce linear and nonlinear vibration analysis of systems.
2. Formulation of continuous system problems and solving them.

COURSE OUTCOMES:

1. Student shall be able to demonstrate knowledge and understanding on concepts of degrees of freedom, vibration control, linear and non-linear vibrations.
2. Application of non-linear analysis problems in practical applications.

R**eview of one degree of freedom free and forced vibrations**, Transient Vibration of single Degree-of freedom systems- Impulse excitation, Arbitrary excitation, Laplace transform formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation,

Vibration Control- Introduction, Vibration isolation theory, Vibration isolation and motion isolation for harmonic excitation, practical aspects of vibration analysis, shock isolation, Dynamic vibration absorbers, and Vibration dampers. Modal analysis & Condition Monitoring, Dynamic Testing of machines and Structures, Experimental Modal analysis, Machine Condition monitoring and diagnosis.

Non Linear Vibrations- Introduction, Sources of nonlinearity, Qualitative analysis of nonlinear systems. Phase plane, Conservative systems, Stability of equilibrium, Method of isoclines, Perturbation method, Method of iteration, Self-excited oscillations.

Random Vibrations - Random phenomena, Time averaging and expected value, Frequency response function, Probability distribution, Correlation, Power spectrum and power spectral density, Fourier transforms, FTs and response.

Continuous Systems- Vibrating string, longitudinal vibration of rods, Torsional vibration of rods, Euler equation for beams.

TEXT BOOKS:

1. William T. Thomson, Marie Dillon Dahleh, Chandramouli Padmanabhan, Theory of Vibration with Application, 5th Edition Pearson Education, 2008.
2. Rao, S. S., Mechanical Vibrations, 4th Edition, Pearson Education, 2004.

REFERENCE BOOKS:

1. Graham Kelly, S., Mechanical Vibrations, Schaum's Outlines, Tata McGraw Hill, 2007.
2. Sujatha, C, Vibraitons and Acoustics - Measurements and signal analysis, Tata McGrawHill, 2009.

SEM/YEAR	**: V SEM**
COURSE CODE	**: 15ME322**
TITLE OF THE COURSE	**: QUALITY & RELIABILITY ENGINEERING**
L: T/A:P: C	**: 3 :0 : 0 : 3**
TOTAL HOURS	**44**

COURSE LEARNING OBJECTIVES

1. To understand importance of concepts of quality control and management in product development
2. To understand concepts of total quality management for different sectors like product development, maintenance.
3. To enable students to understand the different quality management systems like ISO 9000 and 14000 series.
4. To understand the concepts of reliability engineering.

COURSE OUTCOMES

1. Ability to demonstrate different aspects of quality control and management in product development, maintenance engineering.
2. Ability to implement different quality management series for engineering application
3. To implement the concepts of reliability for engineering application.

MODULE I

Quality Control **09 Hrs**

Management of product quality, evolution of quality control, changing quality concepts, modern concept of total quality management, contribution of quality masters (Deming, Juran, Crosby, Ishikawa, Taguchi),process control charts; statistical quality control tools; statistical process control and process capability.

MODULE II

Total Quality Management **09 Hrs**

Total quality management, concept of total quality, total quality maintenance, total quality in service sector; role of customer and people in total quality management; steps for quality improvement, Kaizen; organizing for effective quality management; creating quality by design assessment of customer's needs; formulation of design specifications; standardization; costs of quality; quality circles; 5-S concept;, zero defect programme; Six – Sigma approach.

MODULE III

Quality Management Systems **09 Hrs**

Quality Management Systems: ISO 9000 series of standard; ISO 14000 series of standards, Strategic tools and techniques for TQM, need for tools and techniques in TQM; commonly used tools for TQM; approaches and deployment of tools for quality planning – quality function deployment (QFD), concurrent engineering; tools for continuous improvement

– Deming's Plan – Do – Check – Act (PDCA) cycle, Poka – Yoke (Mistake – Proofing), Taguchi's quality loss function.

MODULE IV

Reliability **09 Hrs**

Reliability,concept and definition, reliability parameters: Reliability as a function of time, failure rate as a function of time, constant failure rate, mean time to failure (MTTF), MTTF as a function of failure rate, mean time between failure (MTBF), mean down time (MDT), maintainability & availability, increasing failure rate, bath-tub curve; Weilbull distribution, System reliability models: series system, parallel system, series-parallel system, six sigma approach in reliability.

MODULE V

Risk Assessment & Reliability in Design **08 Hrs**

Risk assessment & reliability design, causes of failures, failure modes & effects analysis (FMEA), faulty tree analysis (FTA); Tribological failure and monitoring techniques; Design based on reliability, redundancy in design.

Text Books

1. H. Lal, Total Quality Management – A Practical Approach, New Age International (P) Ltd. Publishers, 2015.
2. S. K. Mondal, Total Quality Management Principles and Practice, Vikas Publishing House Pvt. Ltd, 2009.

Reference Books

1. A. V. Feigenbum, Total Quality Control, McGraw-Hill Book Company, 1991.
2. Juran's, Quality Control Handbook, McGraw Hill Book Company, 1988.
3. Amitava Mitra, Fundamentals of quality Control and Improvement, PHI, 2016.