VISVESVARAYA TECHNOLOGICAL UNIVERSITY BELAGAVI

B. E. / B. Tech Manufacturing Science Engineering Scheme of Teaching and Examinations
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
(Effective from the academic year 2018 – 19)

B. E. COMMON TO ALL PROGRAMMES
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

TRANSFORM CALCULUS, FOURIER SERIES AND NUMERICAL TECHNIQUES

Course Code	**18MAT31**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	**03**	Exam Hours	03

Course Learning Objectives:

- To have an insight into Fourier series, Fourier transforms, Laplace transforms, Difference equations and Z-transforms.
- To develop the proficiency in variational calculus and solving ODE's arising in engineering applications, using numerical methods.

Module-1

Laplace Transforms: Definition and Laplace transform of elementary functions. Laplace transforms of Periodic functions and unit-step function – problems.
Inverse Laplace Transforms: Inverse Laplace transform - problems, Convolution theorem to find the inverse Laplace transform (without proof) and problems, solution of linear differential equations using Laplace transform.

Module-2

Fourier Series: Periodic functions, Dirichlet's condition. Fourier series of periodic functions period 2π and arbitrary period. Half range Fourier series. Practical harmonic analysis, examples from engineering field.

Module-3

Fourier Transforms: Infinite Fourier transforms, Fourier sine and cosine transforms. Inverse Fourier transforms. Simple problems.
Difference Equations and Z-Transforms: Difference equations, basic definition, z-transform-definition, Standard z-transforms, Damping and shifting rules, initial value and final value theorems (without proof) and problems, Inverse z-transform. Simple problems.

Module-4

Numerical Solutions of Ordinary Differential Equations (ODE's): Numerical solution of ODE's of first order and first degree- Taylor's series method, Modified Euler's method. Range - Kutta method of fourth order, Milne's and Adam-Bashforth predictor and corrector method (No derivations of formulae), Problems.

Module-5

Numerical Solution of Second Order ODE's: Runge -Kutta method and Milne's predictor and corrector method.(No derivations of formulae).
Calculus of Variations: Variation of function and functional, variational problems, Euler's equation, Geodesics, hanging chain, problems.

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

- CO1: Use Laplace transform and inverse Laplace transform in solving differential/ integral equation arising in network analysis, control systems and other fields of engineering.
- CO2: Demonstrate Fourier series to study the behaviour of periodic functions and their applications in system communications, digital signal processing and field theory.
- CO3: Make use of Fourier transform and Z-transform to illustrate discrete/continuous function arising in wave and heat propagation, signals and systems.
- CO4: Solve first and second order ordinary differential equations arising in engineering problems using single step and multistep numerical methods.
- CO5:Determine the extremals of functionals using calculus of variations and solve problems arising in dynamics of rigid bodies and vibrational analysis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year

Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2016
2	Higher Engineering Mathematics	B. S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition, 2016
Reference Books				
1	Advanced Engineering Mathematics	C. Ray Wylie, Louis C. Barrett	McGraw-Hill Book Co	6th Edition, 1995
2	Introductory Methods of Numerical Analysis	S. S. Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B.V. Ramana	McGraw-Hill	11th Edition,2010
4	A Text Book of Engineering Mathematics	N. P. Bali and Manish Goyal	Laxmi Publications	2014
5	Advanced Engineering Mathematics	Chandrika Prasad and Reena Garg	Khanna Publishing,	2018

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

MATERIAL SCIENCE

Course Code	**18MA32**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 4

Content	Hours/RBT Level
Module 1 **Basics, Mechanical Behavior, Failure of Materials :** Introduction to Crystal Structure – Coordination number, atomic packing factor, Simple Cubic, BCC, FCC and HCP Structures, Crystal imperfections – point, line, surface and volume imperfections, Atomic Diffusion: Phenomenon, Fick's laws of diffusion; Factors affecting diffusion. Mechanical Behavior: Stress-strain diagrams showing ductile and brittle behavior of materials, Engineering and true strains, Linear and non-linear elastic behavior and properties, Mechanical properties in plastic range. Stiffness, Yield strength, Offset Yield strength, Ductility, Ultimate Tensile strength, Toughness, Plastic deformation of single crystal by slip and twinning, Mechanisms of strengthening in metals **Fracture:** Type I, Type II and Type III, **Fatigue:** Types of fatigue loading with examples, Mechanism of fatigue, Fatigue properties, S-N diagram, Fatigue testing. Creep: Description of the phenomenon with examples, three stages of creep, creep properties, Stress relaxation. Concept of fracture toughness.	**8 Hours** **L1, L2, L3**
Module 2 **Alloys, Steels, Solidification:** Concept of formation of alloys: Types of alloys, solid solutions, factors affecting solid solubility (Hume Rothery rules), Binary phase diagrams: Eutectic, and Eutectoid systems, Lever rule, Substitutional and interstitial solid solutions, Intermediate phases, Gibbs phase rule Effect of non- equilibrium cooling, Coring and Homogenization Iron-Carbon (Cementite) diagram: description of phases, Specifications of steels. Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, Crystal growth, Numerical on lever rule.	**8Hours** **L1,L2,L3,L4**
Module 3 **Heat Treatment, Ferrous and Non-Ferrous Alloys :** Heat treating of metals: Time-Temperature-Transformation (TTT) curves, Continuous Cooling Transformation (CCT) curves, Annealing: Recovery, Recrystallization and Grain growth, Types of annealing, Normalizing, Hardening, Tempering, Martempering, Austempering, Concept of hardenability, Factors affecting it hardenability, surface hardening methods: carburizing, cyaniding, nitriding, flame hardening and induction hardening, Age hardening of aluminum-copper alloys and PH steels. Ferrous materials: Properties, Compositions and uses of Grey cast iron, Malleable iron, SG iron and steel.	**8 Hours** **L1,L2,L3,L4**
Module 4 **Other Materials, Material Selection:** Ceramics: Structure types and properties and applications of ceramics. Mechanical / Electrical behavior and processing of Ceramics. Plastics: Various types of polymers/plastics and their applications. Mechanical behaviors and processing of plastics, Failure of plastics. Other materials: Smart materials and Shape Memory alloys, properties and applications.	**8 Hours** **L1,L2,L3,L4**

Module 5	8 Hours
Composite Materials: Composite materials - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber-reinforced composites, Fundamentals of production of composites, Processes for production of composites, Constitutive relations of composites, Numerical problems on determining properties of composites	**L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Describe the mechanical properties of metals, their alloys and various modes of failure.
CO2	Understand the microstructures of ferrous and non-ferrous materials to mechanical properties
CO3	Explain the processes of heat treatment of various alloys.
CO4	Understand the properties and potentialities of various materials available and material selection procedures.
CO5	Explain composite materials, their processing and applications.

Text Books:

1. Foundations of Materials Science and Engineering Smith, , 4th Edition, McGraw Hill, 2009.
2. Material science and Engineering and Introduction William D. Callister, , Wiley, 2006.

Reference Books:

1. Materials Science and Engineering, V.Raghavan, , PHI, 2002
2. The Science and Engineering of Materials, Donald R. Askland and Pradeep.P. Phule, Cengage Learning, 4lh Ed., 2003.
3. Mechanical Metallurgy, George Ellwood Dieter, McGraw-Hill.
4. ASM Handbooks, American Society of Metals.

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SEMESTER - III

BASIC THERMODYNAMICS

Course Code	**18MA33**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module 1 **Basic Concepts:** Basic concepts – concept of continuum, comparison of microscopic and macroscopic approach, Path and point functions, Intensive and extensive properties, total and specific quantities, System and their types, Thermodynamic Equilibrium State, path and process, Quasi-static process, reversible and irreversible processes. **Zeroth law of thermodynamics –** concept of temperature and thermal equilibrium– relationship between temperature scales –new temperature scales, Numerical problems	**8 Hours** **L1, L2, L3**
Module 2 **Heat, Work, And First Law Of Thermodynamics:** Heat and work transfers, definition and comparison, sign convention, Displacement work and other modes of work, P-V diagrams, Numerical problems. **First law of thermodynamics –**application to closed and open systems – steady and unsteady flow processes, Numerical problems	**8 Hours** **L1,L2,L3,L4**
Module 3 **Second Law Of Thermodynamics And Entropy:** Heat Reservoir, source and sink. Heat Engine, Refrigerator, Heat pump, Statements of second law and its corollaries, Carnot cycle, Reversed Carnot cycle, Performance, Numerical problems. Clausius inequality. Concept of entropy, T-s diagram, Tds Equations, entropy change for – pure substance, ideal gases – different processes, principle of increase in entropy, Applications of II Law, High and low grade energy. Available and unavailable energy, Numerical problems.	**8 Hours** **L1,L2,L3,L4**
Module 4 **Availability, Irreversibility, And Pure Substances:** Available and unavailable energies, Exergy and irreversibility, Expressions for exergy of a closed system and open system, Exergy balance and entropy generation, Irreversibility, I and II law Efficiencies, Numerical problems. Formation of steam and its thermodynamic properties, p-v, p-T, T-v, T-s, h-s diagrams, Use of Steam Table and Mollier Chart, Determination of dryness fraction, Numerical problems.	**8 Hours** **L1,L2,L3,L4**
Module 5 **Ideal Gas Mixtures And Real Gases :** Properties of Ideal gas, Mole and Mass fraction, Dalton's and Amagat's Law, Properties of gas mixture – Molar mass, gas constant, density, change in internal energy, enthalpy, entropy and Gibbs function, Numerical problems. Equations of state for ideal and real gases- Reduced properties. Compressibility factor-.Principle of Corresponding states. –Generalized Compressibility Chart and its use, Numerical problems.	**8 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Recall the basic definitions in thermodynamics and zeroth law of thermodynamics.
CO2	Calculate the energy transfers across the boundary of a system and apply the first and second laws of thermodynamics to closed and open systems.
CO3	Recall the concept of entropy and calculate exergy, I and II law efficiencies of systems.
CO4	Calculate thermodynamic properties of pure substances using steam tables and Mollier chart.
CO5	Analyze ideal gas mixtures and real gases.

Text Books:

1. Basic and Applied Thermodynamics, G S Bhat, Yes Dee Pub. 2018
2. Basic and Applied Thermodynamics, P. K. Nag, 2nd Ed., Tata McGraw Hill Pub. 2002
3. An Introduction to Thermodynamcis, Y. V. C. Rao, Wiley Eastern, 1993

Reference Book:

1. Thermodynamics, An Engineering Approach, Yunus A.C enegal and Michael A. Boles, Tata McGraw Hill publications, 2002
2. Fundamentals of Classical Thermodynamics, G. J. Van Wylen and R. E. Sonntag, Wiley Eastern
3. Engineering Thermodynamics, J. B. Jones and G. A. Hawkins, John Wiley and Sons

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

MECHANICS OF MATERIALS

Course Code	**18MA34**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Total Number of Hours	50	Exam. Hours	03

Number of Credits: 4

Content	Hours/RBT Level
Module 1 **Stresses and Strains:** Introduction, Properties of materials, Stress, Strain and Hooke's law, Stress strain diagram for brittle and ductile materials, True stress and strain, Calculation of stresses in straight, Stepped and tapered sections, Composite sections, Stresses due to temperature change, Shear stress and strain, Lateral strain and Poisson's ratio, Elastic constants and relations between them.	**10 Hours** **L1, L2, L3**
Module 2 **Analysis of Stress and Strain:** Plane stress, Stresses on inclined planes, Principal stresses and maximum shear stress, Principal angles, Shear stresses on principal planes, Maximum shear stress, Mohr circle for plane stress conditions. **Cylinders:** Thin cylinder: Hoop's stress, maximum shear stress, circumferential and longitudinal strains, Thick cylinders: Lames equations.	**10 Hours** **L1, L2, L3, L4**
Module 3 **Shear Force and Bending Moment:** Type of beams, Loads and reactions, Relationship between loads, shear forces and bending moments, Shear Force and bending moments of cantilever beams, Pin support and roller supported beams Courseed to concentrated loads, uniformly distributed constant / varying loads. **Stress in Beams:** Bending and shear stress distribution in rectangular, I and T section beams	**10 Hours** **L1, L2, L3, L4**
Module 4 **Theories of Failure:** Maximum Principal stress theory, Maximum shear stress theory for 2 cases. **Torsion:** Circular solid and hallow shafts, Torsional moment of resistance, Pow transmission of straight and stepped shafts, Twist in shaft sections, Thin tubular sections, Th walled sections.	**10 Hours** **L1, L2, L3, L4**
Module 5 **Columns:** Buckling and stability, Critical load, Columns with pinned ends, Columns wi other support conditions, Effective length of columns, Secant formula for columns. **Strain Energy:** Strain energy due to axial, shear, bending, torsion and impact loa Castigliano's theorem I and II and their applications.	**10 Hours** **L1, L2, L3, L4**

Course Outcomes: After studying this course, students will be able to

CO1	Understand simple, compound, thermal stresses and strains their relations and strain energy.
CO2	Analyse structural members for stresses, strains and deformations.
CO3	Analyse the structural members Courseed to bending and shear loads.
CO4	Analyse shafts Courseed to twisting loads.
CO5	Analyse the short columns for stability.

Text Books:

1. Mechanics of Materials, J M Gere, B J Goodno, Eighth Edition, Cengage,2013.
Strength of Materials, S. S. Ratan, 2nd Edition, Tata McGraw Hill,2008.

Reference Books:

1. Strength of Materials, R. Subramanian, Oxford,2005.
Mechanics of materials: Strength of Materials, S C Pilli and N Balasubramanya, Cengage,2011

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

FOUNDRY TECHNOLOGY

Course Code	**18MA35**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module 1 **Introduction:** Introduction to casting process and the steps involved; Components produced by casting process, Comparison of metal casting with metal joining, Advantages and limitations of casting process; Overview of the industry **Solidification of metals:** Introduction, freezing of pure metals; Nucleation and Growth, shrinkage, solidification of alloys; dendritic growth and segregation; shrinkage in alloys; Alloys freezing in two stages; solidification process in eutectic and non-eutectic alloys; Properties related to the solidification mechanism – Fluidity, Hot tearing or hot cracking, Evolution of dissolved gases, Effect of inoculation; Solidification of actual castings; Progressive and directional solidification; Centerline feeding resistance; Rate of solidification; Chvorinov's Rule.	**8 Hours** **L1, L2, L3**
Module 2 **Foundry Furnaces:** Types of foundry furnaces – crucible, pot and reverberatory furnace; Cupola; Electric arc furnace, Induction furnace. **Patterns and pattern making:** Definition, functions; Materials used for patterns, pattern allowances and their significance; Classification of patterns; BIS colour coding of patterns, Core boxes. .	**8 Hours** **L1,L2,L3,L4**
Module 3 **Sand molding:** Types and requirements of base sand; Binders and additives used – types and properties; Molding tools and equipment – hand molding tools, molding machines – Jolt type, squeeze type, Jolt and Squeeze type and Sand slinger; Cores – types, core prints, core venting and baking, core shifting and chaplets, method of making cores, binders used, core sand molding; Gating systems - principles and types of gates and risers, gating ratios and chills, riser location and design in actual casting; Molding processes – bench molding, floor molding, pit molding, stack molding, green sand molding, dry sand molding, loam molding, machine molding.	**8 Hours** **L1,L2,L3,L4**
Module 4 **Special Molding Processes**: Study of important molding processes, No bake molds, Flask less molds, Sweep mold, CO2 mold, Shell mold, Investment mold. Metal Molds: Gravity die casting, Pressure die casting, Centrifugal casting, Squeeze casting, Slush casting, Thixo-casting, Continuous casting.Non-metal molding, Plaster and Ceramic molding; Expandable pattern mold casting. Finishing processes: Fettling and cleaning of castings; removal of gates and risers, grinding. Non-Ferrous Foundry practice: Casting of Al-Si and Al-Mg alloys, Cu-base casting alloys.	**8 Hours** **L1,L2,L3,L4**
Module 5 Foundry Practices of Cast Irons, Steels, Inspection and Testing of Castings: Foundry practice for cast irons – gray iron, white cast iron; Ductile iron, malleable iron, SG iron, Steel castings – steel melting in the foundry; Metallurgy of cast steel; Casting design considerations; Inspection and testing of castings: Defects in castings – types, causes and remedies; Inspection and non-destructive testing of castings. Modernization and mechanization of foundry; Material handling; Pollution control in foundry; Application of computers in casting process; Software available for casting process simulation.	**8 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to	
CO1	Have an Understand the technology, variables and complexity involved in producing a casting.
CO2	Be able to make selection of the type of furnace required for any specific casting problem and design the pattern requirement.
CO3	Have the basic knowledge for selecting the type of sand, for molds and cores as well as the molding process.
CO4	Know about the special molding processes and when their use is warranted.
CO5	Have a broad knowledge of casting of ferrous and non-ferrous alloys and of the inspection techniques to detect casting defects.

Text Books:

1. "Fundamentals of Metal casting", R.A.Flinn, Addison Wesley, 1963.
2. "Principles of Metal casting", R.W. Heine, C.R.Loper & P.C. Rosenthal, Tata McGraw Hill, 2001

Reference Book:

1. "Processes and Materials for Manufacturing", R.A. Lindberg, 4th Ed, Pearson Education, 2006.
2. "Manufacturing Technology: Foundry, forming and welding", P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.
3. "ASM Handbook: Volume 15: Casting" 9th Ed., American Society of Metals, Ohio, 2008.

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

COMPUTER AIDED MACHINE DRAWING

Course Code	**18MA36**	CIE Marks	40
No. of Hours/week (L:T:P)	1:0:4	SEE Marks	60
Total Hours	40	Exam Hours	03

No. of credits: 3

Content	**Hours/RBT Level**
Part A **Introduction:** Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap. Conversion of pictorial views into orthographic projections of simple machine parts (with and without section). Hidden line conventions. Precedence of lines. **Sections of Solids:** 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. Conversion of pictorial views into orthographic projections of simple machine parts. Hidden line conventions. Precedence of lines. Conversion of pictorial views into orthographic projections of simple machine parts (with section planes indicated on the part). **Thread Forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External), BSW (Internal & External) square and Acme. Sellers thread, American Standard thread. **Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.	**10 Hours** **L1, L2, L3, L4**
Part B **Keys:** Parallel key, Taper key, Feather key, Gib-head key and Woodruff key. **Joints:** 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, and universal coupling (Hooks' Joint)	**10 Hours** **L1, L2, L3, L4**
Part C **Limits, Fits and Tolerances:** Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry. **Assembly Drawings:** (Part drawings shall be given) 1. Plummer block (Pedestal Bearing) 2. Lever Safety Valve 3. I.C. Engine connecting rod 4. Screw jack (Bottle type) 5. Tailstock of lathe 6. Machine vice 7. Tool head of shaper	**20 Hours** **L1, L2, L3, L4**

Course Outcomes: After studying this course, students will be able to

CO1	Identify the national and international standards pertaining to machine drawing.
CO2	Understand the importance of the linking functional and visualization aspects in the preparation of the part drawings

CO3	Apply limits and tolerances to assemblies and choose appropriate fits for given assemblies.
CO4	Interpret the Machining and surface finish symbols on the component drawings.
CO5	Preparation of the part or assembly drawings as per the conventions.

Text Books:

1. 'Machine Drawing', K.R. Gopala Krishna, Subhash Publication2005
2. 'Machine Drawing', N.D. Bhat & V.M. Panchal. Charoratar publishing house,2005

Reference books:

1. A Text Book of Computer Aided Machine Drawing', S. Trymbaka Murthy, CBS Publishers, New Delhi,2007.
2. 'Engineering drawing', P.S. Gill, S K Kataria and Sons.2013
3. 'Machine Drawing', N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata McGrawHill

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

MATERIAL TESTING LAB

Course Code	**18MAL37**	CIE Marks	40
Number of Hours/Week (L:T:P)	0:1:2	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 2

Content	Hours/RBTLevel
PART – A 1. Preparation of specimen for Metallographic examination of different engineering materials. Study the microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites. 2. Carryout the heat treatment and observe Annealing, normalizing, hardening and tempering of steel. Study the microstructure of heat treated steel and identify the heat treatment process. 3. Determine the hardness of the steel specimens (Plain Carbon steels and heat treated) using Brinell, Rockwell and Vickers's Hardness testing machines. 4. Using a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing procedures, study the surface and core defects in cast specimens.	**15 Hours** **L2, L3, L4**
PART B **Conduct** a. Tensile, shear and compression tests of steel and aluminum specimens. b. Torsion Test on steel bar. c. Bending Test on wood specimens. d. Impact test using Izod and Charpy procedures on Mild steel Specimen. Study the wear characteristic using Pin-Disc machine Demonstrate the Fatigue Test	**25 Hours** **L2, L3, L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Gain skills in material testing.
CO2	Determine the mechanical properties of ferrous and non-ferrous materials by testing
CO3	Analyze the material Microstructure.

Scheme of Examination:

ONE question from part-A:	30 Marks
ONE question rom part B:	50 Marks
Viva-Voice:	20 Marks
Total:	100 Marks

B. E. MANUFACTURING SCIENCE AND ENGINEERING
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SEMESTER - III

FOUNDRY AND FORGING LAB

Course Code	**18MAL38**	CIE Marks	40
Number of Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Total hours	40	Exam Hours	03

No. of Credits: 2

Content	**Hours/RBT Level**
PART– A Testing of Molding sand and Core sand Preparation of sand specimens and conduction of the following tests: 1. Compression, Shear and Tensile tests on Universal Sand Testing Machine. 2. Permeability test 3. Sieve Analysis to find Grain Fineness Number(GFN) of Base Sand 4. Clay content determination in Base Sand.	**16 Hours** **L1, L2, L3, L4**
PART B **Foundry Practice** 1. Use of foundry tools and other equipment's. 2. Preparation of molding sand mixture. 3. Preparation of green sand molds using two molding boxes kept ready for pouring: • Using patterns (Single piece pattern and Split pattern) • Without patterns. • Incorporating core in the mold. (Core boxes). • Preparation of one casting (Aluminum or cast iron-Demonstration only) **OR** **Forging Operations** : 1. Use of forging tools and other equipment's 2. Calculation of length of the raw material required to prepare the model considering scale loss. 3. Preparing minimum three forged models involving upsetting, drawing and bending operations. 4. Demonstration of forging model using Power Hammer.	**24 Hours** **L1, L2, L3, L4**

Course Outcomes: After learning the course, the student should be able to:

CO1	Demonstrate various skills of sand preparation, molding
CO2	Demonstrate various skills of forging operations.
CO3	Work as a team keeping up ethical principles.

Text Books

1. "Processes and Materials for Manufacturing R.A. Lindberg,", 4th Ed, Pearson Education, 2006.
2. "Manufacturing Technology: Foundry, forming and welding", P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.
3. "ASM Handbook: Volume 15: Casting" 9th Ed., American Society of Metals, Ohio, 2008.

Reference Books

1. "Fundamentals of Metal casting", R.A.Flinn, Addison Wesley, 1963.
2. "Principles of Metal casting", R.W. Heine, C.R.Loper & P.C. Rosenthal, Tata McGraw Hill, 2001.

Scheme of Examination:

ONE question from part-A:	30 Marks
ONE question rom part B:	50 Marks
Viva-Voice:	20 Marks
Total:	100 Marks

B. E. Common to all Programmes
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II / III / IV

Aadalitha Kannada

Course Code	**18KAK28/39/49**		
Teaching Hours/Week (L:T:P)	(0:2:0)	CIE Marks	100
Credits	01		

ಆಡಳಿತ ಕನ್ನಡ ಕಲಿಕೆಯ ಉದ್ದೇಶಗಳು:

- ಪದವಿ ವಿದ್ಯಾರ್ಥಿಳಾಗಿರುವುದರಿಂದ ಆಡಳಿತ ಕನ್ನಡದ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾ ಬರಹದಲ್ಲಿ ಕಂಡುಬರುವ ದೋಷಗಳು ಹಾಗೂ ಅವುಗಳ ನಿವಾರಣೆ. ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳನ್ನು ಪರಿಚಯಿಸುವುದು.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡಿಸುವುದು.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಅಸಕ್ತಿ ಮೂಡಿಸುವುದು.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ್ತು ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳ ಪರಿಚಯ ಮಾಡಿಕೊಡುವುದು.

ವಿಡಿ (ಪಠ್ಯಪುಸ್ತಕದಲ್ಲಿರುವ ವಿಷಯಗಳ ಪಟ್ಟಿ)

ಅಧ್ಯಾಯ – 1 ಕನ್ನಡಭಾಷೆ – ಸಂಕ್ಷಿಪ್ತ ವಿವರಣೆ.

ಅಧ್ಯಾಯ – 2 ಭಾಷಾ ಪ್ರಯೋಗದಲ್ಲಾಗುವ ಲೋಪದೋಷಗಳು ಮತ್ತು ಅವುಗಳ ನಿವಾರಣೆ.

ಅಧ್ಯಾಯ – 3 ಲೇಖನ ಚಿಹ್ನೆಗಳು ಮತ್ತು ಅವುಗಳ ಉಪಯೋಗ.

ಅಧ್ಯಾಯ – 4 ಪತ್ರ ವ್ಯವಹಾರ.

ಅಧ್ಯಾಯ – 5 ಆಡಳಿತ ಪತ್ರಗಳು.

ಅಧ್ಯಾಯ – 6 ಸರ್ಕಾರದ ಆದೇಶ ಪತ್ರಗಳು.

ಅಧ್ಯಾಯ – 7 ಸಂಕ್ಷಿಪ್ತ ಪ್ರಬಂಧ ರಚನೆ (ಪ್ರಿಸೈಸ್ ರೈಟಿಂಗ್), ಪ್ರಬಂಧ ಮತ್ತು ಭಾಷಾಂತರ.

ಅಧ್ಯಾಯ – 8 ಕನ್ನಡ ಶಬ್ದಸಂಗ್ರಹ.

ಅಧ್ಯಾಯ – 9 ಕಂಪ್ಯೂಟರ್ ಹಾಗೂ ಮಾಹಿತಿ ತಂತ್ರಜ್ಞಾನ.

ಅಧ್ಯಾಯ – 10 ಪಾರಿಭಾಷಿಕ ಆಡಳಿತ ಕನ್ನಡ ಪದಗಳು ಮತ್ತು ತಾಂತ್ರಿಕ/ ಕಂಪ್ಯೂಟರ್ ಪಾರಿಭಾಷಿಕ ಪದಗಳು.

ಆಡಳಿತ ಕನ್ನಡ ಕಲಿಕೆಯ ಫಲಿತಾಂಶ'ಗಳು:

- ಆಡಳಿತ ಭಾಷೆ ಕನ್ನಡದ ಪರಿಚಯವಾಗುತ್ತದೆ.
- ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯ ವ್ಯಾಕರಣದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡುತ್ತದೆ.
- ಕನ್ನಡ ಭಾಷಾ ರಚನೆಯಲ್ಲಿನ ನಿಯಮಗಳು ಮತ್ತು ಲೇಖನ ಚಿಹ್ನೆಗಳು ಪರಿಚಯಿಸಲ್ಪಡುತ್ತವೆ.
- ಸಾಮಾನ್ಯ ಅರ್ಜಿಗಳು, ಸರ್ಕಾರಿ ಮತ್ತು ಅರೆ ಸರ್ಕಾರಿ ಪತ್ರವ್ಯವಹಾರದ ಬಗ್ಗೆ ಅರಿವು ಮೂಡುತ್ತದೆ.
- ಭಾಷಾಂತರ ಮತ್ತು ಪ್ರಬಂಧ ರಚನೆ ಬಗ್ಗೆ ಅಸಕ್ತಿ ಮೂಡುತ್ತದೆ.
- ಕನ್ನಡ ಭಾಷಾಭ್ಯಾಸ ಮತ್ತು ಸಾಮಾನ್ಯ ಕನ್ನಡ ಹಾಗೂ ಆಡಳಿತ ಕನ್ನಡದ ಪದಗಳು ಪರಿಚಯಿಸಲ್ಪಡುತ್ತವೆ.

ಪರೀಕ್ಷೆಯ ವಿಧಾನ : ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನ – ಅಖಇ **(ಅಟಿಣಟಿಣಟಿಣಾ ಖಟಿಣಜಿಟಿಚಿಟಿ ಇತಿಚಿಟಿಣಚಿಣಟಿ):**
ಕಾಲೇಜು ಮಟ್ಟದಲ್ಲಿಯೆ ಆಂತರಿಕ ಪರೀಕ್ಷೆಯನ್ನು 100 ಅಂಕಗಳಿಗೆ ವಿಶ್ವವಿದ್ಯಾಲಯದ ನಿಯಮಗಳು ಮತ್ತು ನಿರ್ದೇಶನದಂತೆ ನಡೆಸತಕ್ಕದ್ದು.

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II & III/IV

Vyavaharika Kannada

Course Code	**18KVK28/39/49**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:2:0)		
Credits	01		

Course Learning Objectives:
The course will enable the students to understand Kannada and communicate in Kannada language.

Table of Contents:

Course Outcomes:
At the end of the course, the student will be able to understand Kannada and communicate in Kannada language.

ಪರೀಕ್ಷೆಯ ವಿಧಾನ : ನಿರಂತರ ಆಂತರಿಕ ಮೌಲ್ಯಮಾಪನ – ಅಭಇ **(ಅಟಿಣಟಿಣಠಿಣಾ ಖಟಿಣಜಿಟಿಚಿಟ ಇಠಚಿಟಿಣಚಿಣಟಿ):**
ಕಾಲೇಜು ಮಟ್ಟದಲ್ಲಿಯೆ ಆಂತರಿಕ ಪರೀಕ್ಷೆಯನ್ನು 100 ಅಂಕಗಳಿಗೆ ವಿಶ್ವವಿದ್ಯಾಲಯದ ನಿಯಮಗಳು ಮತ್ತು ನಿರ್ದೇಶನದಂತೆ ನಡೆಸತಕ್ಕದ್ದು.

ಖಿಜ್ಞಾಛಜ್ಞಾ (ಪಠ್ಯಪುಸ್ತಕ): ವ್ಯಾವಹಾರಿಕ ಕನ್ನಡ ಪಠ್ಯ ಪುಸ್ತಕ (ಗಿಥಿಚಿಜಚಿಖಿಚಿಡಿಜ್ಞಾಚಿ ಏಚಿಟಿಟಿಚಿಜಚಿ ಖಿಜ್ಞಾ ಃಡಜ್ಞಾ)

ಸಂಪಾದಕರು

ಡಾ. ಎಲ್. ತಿಮ್ಮೇಶ

ಪ್ರೊ. ವಿ. ಕೇಶವಮೂರ್ತಿ

ಪ್ರಕಟಣೆ : ಪ್ರಸಾರಾಂಗ, ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಬೆಳಗಾವಿ.

B. E. COMMON TO ALL PROGRAMMES
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (CPC)

Course Code	**18CPC39/49**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

Course Learning Objectives: To

- know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens
- Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
- Know about the cybercrimes and cyber laws for cyber safety measures.

Module-1

Introduction to Indian Constitution: The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.

Module-2

Union Executive and State Executive: Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles 370.371,371J) for some States.

Module-3

Elections, Amendments and Emergency Provisions: Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44, 61, 73,74, ,75, 86, and 91,94,95,100,101,118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences.

Constitutional special provisions: Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

Module-4

Professional / Engineering Ethics: Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institutionof Engineers (India): Profession, Professionalism, and ProfessionalResponsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering

Module-5

Internet Laws, Cyber Crimes and Cyber Laws: Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

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

- CO1: Have constitutional knowledge and legal literacy.
- CO2: Understand Engineering and Professional ethics and responsibilities of Engineers.
- CO3: Understand the the cybercrimes and cyber laws for cyber safety measures.

Question paper pattern for SEE and CIE:

- The SEE question paper will be set for 100 marks and the marks scored by the students will

proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ). • For the award of 40 CIE marks, refer the University regulations 2018.				
Sl. No.	**Title of the Book**	**Name of the Author/s**	**Name of the Publisher**	**Edition and Year**
Textbooks				
1	Constitution of India, Professional Ethics and Human Rights	Shubham Singles, Charles E. Haries, and et al	Cengage Learning India	2018
2	Cyber Security and Cyber Laws	Alfred Basta and et al	Cengage Learning India	2018
Reference Books				
3	Introduction to the Constitution of India	Durga Das Basu	Prentice –Hall,	2008.
4	Engineering Ethics	M. Govindarajan, S. Natarajan, V. S. Senthilkumar	Prentice –Hall,	2004

B. E. Common to all Programmes
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

ADDITIONAL MATHEMATICS – I
(Mandatory Learning Course: Common to All Programmes)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B.Tech. programmes)

Course Code	**18MATDIP31**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:1:0)	SEE Marks	60
Credits	0	Exam Hours	03

Course Learning Objectives:

- To provide basic concepts of complex trigonometry, vector algebra, differential and integral calculus.
- To provide an insight into vector differentiation and first order ODE's.

Module-1

Complex Trigonometry: Complex Numbers: Definitions and properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof).
Vector Algebra: Scalar and vectors. Addition and subtraction and multiplication of vectors- Dot and Cross products, problems.

Module-2

Differential Calculus: Review of elementary differential calculus. Polar curves –angle between the radius vector and the tangent pedal equation- Problems. Maclaurin's series expansions, problems.
Partial Differentiation: Euler's theorem for homogeneous functions of two variables. Total derivatives - differentiation of composite function. Application to Jacobians of order two.

Module-3

Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl and Laplacian (Definitions only). Solenoidal and irrotational vector fields-Problems.

Module-4

Integral Calculus: Review of elementary integral calculus. Statement of reduction formulae for $\sin^n x, \cos^n x, and\ \sin^m x \times \cos^n x$and evaluation of these with standard limits-Examples. Double and triple integrals, problems.

Module-5

Ordinary differential equations (ODE's): Introduction-solutions of first order and first degree differential equations: Variable Separable methods, exact and linear differential equations of order one. Application to Newton's law of cooling.

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

- CO1: Apply concepts of complex numbers and vector algebra to analyze the problems arising in related area.
- CO2: Use derivatives and partial derivatives to calculate rate of change of multivariate functions.
- CO3: Analyze position, velocity and acceleration in two and three dimensions of vector valued functions. CO4: Learn techniques of integration including the evaluation of double and triple integrals.
- CO5: Identify and solve first order ordinary differential equations.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
Reference Books				

1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2015
2	Engineering Mathematics Vol.I	RohitKhurana	Cengage Learning	2015

B. E. COMMON TO ALL PROGRAMMES
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

COMPLEX ANALYSIS, PROBABILITY AND STATISTICAL METHODS

Course Code	**18MAT41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To provide an insight into applications of complex variables, conformal mapping and special functions arising in potential theory, quantum mechanics, heat conduction and field theory.
- To develop probability distribution of discrete, continuous random variables and joint probability distribution occurring in digital signal processing, design engineering and microwave engineering.

Module-1

Calculus of complex functions: Review of function of a complex variable, limits, continuity, and differentiability. Analytic functions: Cauchy-Riemann equations in Cartesian and polar forms and consequences.
Construction of analytic functions: Milne-Thomson method-Problems.

Module-2

Conformal transformations: Introduction. Discussion of transformations:$w = Z^2, w = e^z, w = z + \frac{1}{z}, (z \neq 0)$.Bilinear transformations- Problems.
Complex integration: Line integral of a complex function-Cauchy's theorem and Cauchy's integral formula and problems.

Module-3

Probability Distributions: Review of basic probability theory. Random variables (discrete and continuous), probability mass/density functions. Binomial, Poisson, exponential and normal distributions- problems (No derivation for mean and standard deviation)-Illustrative examples.

Module-4

Statistical Methods: Correlation and regression-Karl Pearson's coefficient of correlation and rank correlation -problems. Regression analysis- lines of regression –problems.
Curve Fitting: Curve fitting by the method of least squares- fitting the curves of the form-
$y = ax + b, y = ax^b and y = ax^2 + bx + c.$

Module-5

Joint probability distribution: Joint Probability distribution for two discrete random variables, expectation and covariance.
Sampling Theory: Introduction to sampling distributions, standard error, Type-I and Type-II errors. Test of hypothesis for means, student's t-distribution, Chi-square distribution as a test of goodness of fit.

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

- Use the concepts of analytic function and complex potentials to solve the problems arising in electromagnetic field theory.
- Utilize conformal transformation and complex integral arising in aerofoil theory, fluid flow visualization and image processing.
- Apply discrete and continuous probability distributions in analyzing the probability models arising in engineering field.
- Make use of the correlation and regression analysis to fit a suitable mathematical model for the statistical data.
- Construct joint probability distributions and demonstrate the validity of testing the hypothesis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

Sl. No.	Title of the Book	Name of the	Name of the	Edition and Year

		Author/s	Publisher	
Textbooks				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition,2016
2	Higher Engineering Mathematics	B. S. Grewal	Khanna Publishers	44th Edition, 2017
3	Engineering Mathematics	Srimanta Pal et al	Oxford University Press	3rd Edition,2016
Reference Books				
1	Advanced Engineering Mathematics	C. Ray Wylie, Louis C.Barrett	McGraw-Hill	6th Edition 1995
2	Introductory Methods of Numerical Analysis	S.S.Sastry	Prentice Hall of India	4th Edition 2010
3	Higher Engineering Mathematics	B. V. Ramana	McGraw-Hill	11th Edition,2010
4	A Text Book of Engineering Mathematics	N. P. Bali and Manish Goyal	Laxmi Publications	2014

Web links and Video Lectures:

1. http://nptel.ac.in/courses.php?disciplineID=111
2. http://www.class-central.com/subject/math(MOOCs)
3. http://academicearth.org/
4. VTU EDUSAT PROGRAMME - 20

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

THEORY OF MACHINES

Course Code	**18MA42**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Total Number of Hours	50	Exam. Hours	03

Number of Credits: 4

Content	Hours/RBT Level
Module 1 **Introduction**: Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, 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. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism.	**10 Hours** **L1, L2, L3**
Module 2 **Velocity and Acceleration Analysis of Mechanisms (Graphical and Analytical Methods):** Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism. Mechanism illustrating Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing.	**10 Hours** **L1,L2,L3**
Module 3 **Spur Gears:** Gear terminology, law of gearing, Path of contact, Arc of contact, Contact ratio of spur gear. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth. Rack & Pinion **Gear Trains:** Simple gear trains, Compound gear trains. Epicyclic gear trains - Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains	**10 Hours** **L1,L2,L3**
Module 4 Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives. Ratio of belt tensions, centrifugal tension and power transmitted. V-Belt Drive: Ratio of belt tensions, power transmitted.	**10 Hours** **L1,L2,L3**
Module 5 **Cams**: Types of cams, Types of followers. Displacement, Velocity and Acceleration curves for SHM. Cam profiles - Disc cam with reciprocating follower having knife-edge, roller and flat-face follower. **Analysis of Cams**: Analysis of Tangent cam with roller follower	**10 Hours** **L1,L2,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	Identify mechanisms, predict their motion and calculate the degrees of freedom of mechanisms.
CO2	analyze the kinematics of a linkage to determine position, velocity and acceleration variation on mechanisms throughout its range of motion
CO3	develop skills for designing and analyzing linkages, cams, gears, gear train and other mechanisms to produce a desired motion.
CO4	understand the different methods of obtaining a mechanism and provide a foundation for the study of machine design.

Text Books:

1. "Theory of Machines", Rattan S.S, Tata McGraw-Hi ll Publishing Company Ltd., New Delhi, and 3rd edition -2009.
2. "Theory of Machines", Sadhu Singh, Pearson Educa tion (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006.

Reference Book:

1. "Theory of Machines & Mechanisms ", J.J. Uicker, , G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.
2. Mechanism and Machine theory , Ambekar, PHI, 2007

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

JOINING PROCESSES

Course Code	**18MA43**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module 1 **Introduction and Concepts:** Definition, principles, classification, applications, advantages and limitations and safety considerations in welding; Basic principles of sound welding design, representation of weld symbols, edge preparation methods; Concepts of dissimilar metal welding, principle of welding plastics, plastic welding processes; Welding jigs and fixtures, automation in welding, welding cost estimation. **Weldability:** Definition of weldability, factors affecting weldability; Weldability tests-mechanical tests; Cold cracking tests and hot cracking tests.	**8 Hours** **L1, L2**
Module 2 **Arc Welding** - principles, equipment, safety recommendations for installation and operation of arc welding equipments; Coated electrodes: electrode coatings, classification of coatings of electrodes for SMAW, SAW ; Fluxes, role of flux ingredients and shielding gases; Classification of solid and flux code wires; Flux shielded metal arc welding(FSMAW), inert gas welding(TIG & MIG); Submerged arc welding, atomic hydrogen welding, electro slag welding **Gas Welding** - principle, equipment, Safety considerations for installation and operation of gas welding equipments; Oxy-acetylene welding, oxy-hydrogen welding; Chemical reactions in gas welding, flame characteristics; Gas torch construction and working, forward and backward welding.	**8 Hours** **L1,L2,L3**
Module 3 **Special Types of Welding, Welding of Steels and other Materials:** Resistance welding - principles, variables in resistance welding, spot welding, seam welding, resistance butt welding, projection welding, resistance welding of tubes; Solid state welding – principles, cold welding, diffusion welding, ultrasonic welding; Explosive welding, friction welding, forge welding; Radiant energy welding – electron beam welding, laser beam welding explosive welding; thermit welding, under water welding, friction stir welding.	**8 Hours** **L2,L3**
Module 4 **Soldering –**definition, principles, soldering joint design; Soldering alloys, Soldering fluxes, different soldering methods; Metallurgical aspects of soldering; Applications, Advantages and limitations of soldering **Brazing–**Definition, principles, brazing joint design; Brazing alloys, brazing fluxes; Brazing processes- torch brazing, furnace brazing, vacuum brazing; Induction brazing, dip brazing, silver brazing; Metallurgical aspects of brazing , Applications, advantages and limitations of brazing **Adhesive bonding-**Steps involved in adhesive bonding; Selection and types of adhesives, applications, advantages and limitations of adhesive bonding.	**8 Hours** **L1,L2,L3**
Module 5 **Metallurgical aspects in welding**- structure of welds; Formation of different zones during welding, heat affected zone(HAZ) and Parameters; Effect of carbon content on structure and properties of steel; Shrinkage in welding, residual stresses and stress relief techniques. Welding defects- types of defects, causes and remedies. **Inspection methods-**visual, magnetic particle, fluorescent particle; Ultrasonic, radiographic, eddy current, holography techniques.	**8 Hours** **L2,L3**
Course Outcomes: After studying this course, students will be able to	

CO1	Have Knowledge of basic principles, classification and concepts involved, limitations, specifications and defects of joining processes like welding, soldering, brazing, adhesive bonding.
CO2	Know the various basic and special welding processes and techniques.
CO3	Be able to understand metallurgical aspects in welding, equations, Testing methods for specific requirements of different metals.

Text Books:

1. "Modern Welding Technology", Howard B Cary, Prentice Hall, 2005.
2. “Manufacturing Technology: Foundry Forming and welding”, P.N.Rao, 3rd Ed., Tata McGraw Hill, 2003.

Reference Books:

1. "Welding Brazing and Soldering", ASM Metals Handbook, Vol. 6, ASM International, Ohio, 2003.
2. “Welding Science and Technology AWS Welding hand book,”, American Welding Society, 2001.
3. “Metallurgy of welding”, Lancaster J F, Woodhead Publishing, 1999

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

FLUID MECHANICS AND MACHINES

Course Code	**18MA44**	CIE Marks	40
Number of Hours/Week (L:T:P)	2:2:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module 1 **Properties of Fluids:** Types of fluid, Properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitation. **Fluid Statistics:** Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers.	**8 Hours** **L1, L2, L3**
Module 2 **Fluid Kinematics:** Types of fluid flow, continuity equation in 2D (Cartesian Co-ordinates only), velocity and acceleration, velocity potential function and stream function. **Fluid Dynamics:** Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation.	**8 Hours** **L1,L2,L3,L4**
Module 3 **Fluid Flow Measurements:** Venturimeter, orifice meter, pitot-tube, vertical orifice, V-Notch and rectangular notches. **Dimensional Analysis:** Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham π theorem, dimensionless numbers, similitude, types of similitudes.	**8 Hours** **L1,L2,L3,L4**
Module 4 **Flow through pipes :** Darcy's and Chezy's equation for loss of head due to friction in pipes. **Laminar flow and viscous effects :** Reyonold's number, critical Reynold's number, laminar flow through circular pipes-Hagen Poiseille's equation, laminar flow between parallel and stationary plates.	**8 Hours** **L1, L2, L3, L4**
Module 5 **Centrifugal Pumps:** Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems. **Centrifugal Compressors:** Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems. Axial flow Compressors: Expression for pressure ratio developed in a stage, work done factor, efficiencies and stalling. Problems.	**8 Hours** **L1, L2, L3, L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Understand properties of fluids and hydrostatics.
CO2	Formulate and solve equations of the control volume for fluid flow systems.
CO3	Develop basic knowledge of dimensional analysis and similitude.
CO4	Calculate resistance to flow of incompressible fluids through closed conduits.
CO5	Solve field problems in flow measurement.
CO6	Select pumps and compressors for different applications.

Text Books:

1. James E.A., John and Haberm W.A., Introduction to Fluid Mechanics, Prentice Hall of India.
2. V. L. Streeter and E. B. Wylie, Fluid Mechanics, Tata McGraw Hill Pvt Ltd. New Delhi, 2nd Edition.

3. R. K. Bansal, Fluid Mechanics, Laxmi Publication (P) Ltd. New Delhi.

Reference Book:

1. Y .A. Cengel, J. M. Cimbala, Fluid Mechanics –Fundamentals and Application, TMI.
2. S. K. Som and G. Biswas, Introduction to Fluid Mechanics and Fluid Machines, TMH.
3. R.K. Rajput, Fluid Mechanics and Hydraulic Machines, S. Chand, and Company Ltd

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

MACHINE TOOLS AND OPERATIONS

Course Code	**18MA45**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	**Hours/RBTLevel**
Module 1 **Machine Tools:** Introduction, Classification, construction and specifications of lathe, drilling machine, milling machine, boring machine, broaching machine, shaping machine, planing machine, grinding machine [Simple sketches showing major parts of the machines]	**8 Hours** **L1, L2, L3**
Module 2 **Machining Processes:** Introduction, Types of motions in machining, turning and Boring, Shaping, Planing and Slotting, Thread cutting, Drilling and reaming, Milling, Broaching, Gear cutting and Grinding, Machining parameters and related quantities.[Sketches pertaining to relative motions between tool and work piece only]	**8 Hours** **L1,L2,L3**
Module 3 **Cutting Tool Materials, Geometry And Surface Finish:** Introduction, desirable Properties and Characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish. **Machining equations for cutting operations:** Turning, Shaping, Planing, slab milling, cylindrical grinding and internal grinding.	**8 Hours** **L1,L2,L3**
Module 4 **Mechanics Of Machining Processes:** Introduction, Chip formation, Orthogonal cutting, Merchants model for orthogonal cutting, Oblique cutting, Mechanics of turning process, Mechanics of drilling process, Mechanics of milling process.	**8 Hours** **L1,L2,L3**
Module 5 **Tool Wear, Tool Life**: Introduction, tool wear mechanism, tool wear equations, tool life equations, effect of process parameters on tool life, machinability **Economics Of Machining Processes:** Introduction, choice of feed, choice of cutting speed, tool life for minimum cost and minimum production time, machining at maximum efficiency.	**8 Hours** **L1,L2,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	Explain the construction & specification of various machine tools.
CO2	Describe various machining processes pertaining to relative motions between tool & work piece.
CO3	Discuss different cutting tool materials, tool nomenclature & surface finish.
CO4	Apply mechanics of machining process to evaluate machining time.
CO5	Analyze tool wear mechanisms and equations to enhance tool life and minimize machining cost.

Text Books:

1. Fundamentals of metal cutting and Machine Tools, B.L. Juneja, G.S. Sekhon and Nitin Seth, New Age International Publishers 2nd Edition, 2003
2. All about Machine Tools, Heinrich Gerling, New Age International Publishers revised 2nd Edition, 2006

Reference Book:

1. Fundamental of Machining and Machine Tools, Geoffrey Boothroyd and Winston A.
2. Knight, CRC Taylor & Francis, Third Edition.
3. "Manufacturing Technology,Vol 2, P N Rao, McGraw Hill Education, 3rd Edition
4. Metal cutting principles, Milton C. Shaw, Oxford University Press, Second Edition, 2005.

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - IV

MECHANICAL MEASUREMENTS AND METROLOGY

Course Code	**18MA46**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module 1 **Introduction to Metrology:** Definition, objectives of metrology, Material Standards, Wavelength Standards, Classification of standards, Line and End standards, Calibration of End bars. Numerical examples. **Liner measurement and angular measurements:** Slip gauges-Indian standards on slip gauges, Adjustable slip gauges, Wringing of slip gauges, Problems on building of slip gauges (M87, M112), Measurement of angle-sine bar, Sine centre, Angle gauges, Optical instruments for angular measurements. Autocollimator-Applications for measuring straightness and squareness.	**8 Hours** **L1, L2, L3**
Module 2 **System of Limits, Fits, Tolerance and Gauging:** Definitions, Tolerance, Tolerance analysis (addition & subtraction of tolerances) Interchangeability & Selective assembly. Class &grade of tolerance, Fits, Types of fits, Numerical on limits, fit and tolerance. Hole base system & shaft base system. Taylor's principle, Types of limit gauges, Numerical on limit gauge design. **Comparators:** Functional requirements, Classification, Mechanical- Johnson Mikrokator, Sigma comparators, Dial indicator, Electrical comparators, LVDT, Pneumatic comparators- Principle of back pressure, Solex comparators, Optical comparators- Zeiss ultra optimeter.	**8 Hours** **L1, L2, L3**
Module 3 **Measurement of screw thread and gear:** Terminology of screw threads, Measurement of major diameter, Minor diameter, Pitch, Angle and Effective diameter of screw threads by 2-wire and 3-wire methods, Best size wire. Screw thread gauges, Toolmaker's microscope. **Gear tooth Measurements:** Tooth thickness measurement using constant chord method, Addendum, Comparator method and Base tangent method, Measurement of pitch, Concentricity, Run out and Involute profile. Gear roll tester for composite error.	**8 Hours** **L1, L2, L3**
Module 4 **Measurement system and basic concepts of measurement methods**: Definition, Significance of measurement, Generalized measurement system, Static characteristics- Accuracy, Precision, Calibration, Threshold, Sensitivity, Hysteresis, Repeatability, Linearity, Loading effect, Dynamic characteristics- System response, Time delay. Errors in measurement, Classification of errors. Transducers: Transfer efficiency, Primary and Secondary transducers, Electrical transducers, Mechanical transducers, Electronic transducers, Relative comparison of each type of transducers. **Intermediate Modifying and Terminating Devices:** Mechanical systems, Inherent problems, Electrical intermediate modifying devices, Input circuitry, Ballast circuit, Electronic amplifiers. Terminating devices, Cathode ray oscilloscope, Oscillographs.	**8 Hours** **L1, L2, L3**
Module 5 **Applied mechanical measurement:** Measurement of force, Torque, Pressure, Types of Dynamometers, Absorption dynamometer, Prony brake and Rope brake dynamometer, and Power Measuring Instruments. Use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. **Measurement of strain and temperature:** Theory of strain gauges, Types, Electrical resistance strain gauge, Preparation and mounting of Strain gauges, Gauge factor, Methods of strain measurement, temperature compensation, Resistance thermometers,	**8 Hours** **L1, L2, L3**

Thermocouple, Law of thermocouple, Pyrometer, Optical pyrometer.	
Course Outcomes: After studying this course, students will be able to:	
CO1	To understand the concept of metrology and standards of measurement.
CO2	To equip with knowledge of limits, fits, tolerances and gauging
CO3	To acquire knowledge of linear and Angular measurements, Screw thread and gear measurement & comparators.
CO4	To understand the knowledge of measurement systems and methods with emphasis on different Transducers, intermediate modifying and terminating devices.
CO5	To understand the measurement of Force, Torque, Pressure, Temperature and Strain.

Text Books:

1. Basic and Applied Thermodynamics, P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002
2. Basic Engineering Thermodynamics, A.Venkatesh, Universities Press, 2008
3. Basic Thermodynamics, B.K Venkanna, Swati B. Wadavadagi, PHI, New Delhi, 2010

Reference Book:

1. Thermodynamics, An Engineering Approach, Yunus A.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2002
2. Engineering Thermodynamics, J.B.Jones and G.A.Hawkins, John Wiley and Sons..
3. Fundamentals of Classical Thermodynamics, G.J.Van Wylen and R.E.Sonntag, Wiley Eastern.
4. An Introduction to Thermodynamcis, Y.V.C.Rao, Wiley Eastern, 1993

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SEMESTER - IV

FLUID MECHANICS AND MACHINERY LAB

Course Code	**18MAL47**	CIE Marks	40
Number of Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Total hours	40	Exam Hours	03

No. of Credits: 2

Content	**Hours/RBT Level**
PART – A 1. Lab layout, calibration of instruments and standards to be discussed 2. Determination of coefficient of friction of flow in a pipe. 3. Determination of minor losses in flow through pipes. 4. Application of momentum equation for determination of coefficient of impact of jets on flat and curved blades 5. Calibration of flow measuring devices. Orifice meter, Nozzle, Venturimeter, V-notch.	15 Hours L1, L2, L3, L4
PART B 1. Performance on hydraulic Turbines a. Pelton wheel b. Francis Turbine c. Kaplan Turbines 2. Performance hydraulic Pumps d. Single stage and Multi stage centrifugal pumps e. Reciprocating pump. 3. Performance test on a two stage Reciprocating Air Compressor. 4. Performance test on an Air Blower	25 Hours L1, L2, L3, L4

Course Outcomes:

CO1	Perform experiments to determine the coefficient of discharge of flow measuring devices.
CO2	Conduct experiments on hydraulic turbines and pumps to draw characteristics.
CO3	Test basic performance parameters of hydraulic turbines and pumps and execute the knowledge in real life situations
CO4	Determine the energy flow pattern through the hydraulic turbines and pumps
CO5	Exhibit his competency towards preventive maintenance of hydraulic machines

Scheme of Examination:

ONE question from part-A:	30Marks
ONE question from part-B:	50Marks
Viva-Voice:	20Marks
Total:	100Marks

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SEMESTER - IV

MECHANICAL MEASUREMENTS AND METROLOGY

Course Code	**18MAL48**	CIE Marks	40
Number of Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Total hours	40	Exam Hours	03

No. of Credits: 2

Content	**Hours/RBT Level**
PART – A MECHANICAL MEASUREMENTS 1) Calibration of Pressure Gauge 2) Calibration of Thermocouple 3) Calibration of LVDT 4) Calibration of Load cell 5) Determination of modulus of elasticity of a mild steel specimen using strain gauges.	15 Hours L1, L2, L3, L4
PART B METROLOGY 6) Measurements using Optical Projector / Toolmakers' Microscope. 7) Measurement of angle using Sine Centre / Sine bar / bevel protractor 8) Measurement of alignment using Autocollimator / Roller set. 9) Measurement of cutting tool forces using a) Lathe tool Dynamometer b) Drill tool Dynamometer. 10) Measurements of Screw thread parameters using two wire or three-wire methods. 11) Measurements of surface roughness using Tally Surf/Mechanical Comparator 12) Measurement of gear tooth profile using gear tooth Vernier/Gear tooth micrometer 13) Calibration of Micrometer using slip gauges 14) Measurement using Optical Flats	25 Hours L1, L2, L3, L4

Course Outcomes: After learning the course, the student should be able

CO1	Calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.
CO2	Measure angle using Sine Centre/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.
CO3	Demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.
CO4	Measure cutting tool forces using Lathe/Drill tool dynamometer.
CO5	Measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth Vernier/Gear tooth micrometer.
CO6	Measure surface roughness using Tally Surf/ Mechanical Comparator.

Scheme of Examination:

ONE question from part-A:	30Marks
ONE question from part-B:	50Marks
Viva-Voice:	20Marks
Total:	100Marks

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

MANAGEMENT AND ENTREPRENEURSHIP

Course Code	**18MA51**	CIE Marks	40
Number of Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Total Hours	40	Exam Hours	03

No. Of Credits:3

Content	**Hours/RBT levels**
Module 1 **MANAGEMENT & ENTERPRENEURSHIP:** Introduction – Meaning – nature and characteristics of Management, Scope and Functional areas of management – Management as a science, art of profession – Management & Administration – Roles of Management, Levels of Management, Development of Management Thought – early management approaches – Modern management approaches. Meaning of Entrepreneur; Evolution of the Concept, Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging Class. Concept of Entrepreneurship – Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development.	**8 Hours** **L1, L2, L3**
Module 2 **PLANNING & ORGANIZING:** Nature, importance and purpose of planning process – Objectives – Types of plans (Meaning only) – Decision making – Importance of planning – steps in planning & planning premises – Hierarchy of plans. Nature and purpose of organization – Principles of organization – Types of organization – Departmentation – Committees- Centralization Vs Decentralization of authority and responsibility – Span of control.	**8 Hours** **L1, L2, L3**
Module 3 **STAFFING, DIRECTING & CONTROLLING:** MBO and MBE (Meaning Only) Nature and importance of staffing–Process of Selection & Recruitment (in brief). Meaning and nature of directing – Leadership styles, Motivation Theories, Communication – Meaning and importance – coordination, meaning and importance and Techniques of Co –Ordination. Meaning and steps in controlling – Essentials of a sound control system – Methods of establishing control (in brief).	**8 Hours** **L1, L2, L3**
Module 4 **SMALL SCALE INDUSTRIES & INSTITUTIONAL SUPPORT:** Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI – Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GATT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition Only) Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.	**8 Hours** **L1, L2, L3**
Module 5 **PREPARATION OF PROJECT:** Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.	**8 Hours** **L1, L2, L3, L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Explain need, functions, roles, scope and evolution of Management, purpose of Planning and

	hierarchy of planning and also analyze its types.
CO2	Discuss Decision making, Organizing, Staffing, Directing and Controlling.
CO3	Understand and small scale industries and compare the different schemes in India for entrepreneurship.
CO4	Understand the market feasibility, technical feasibility, financial feasibility and social feasibility.

TEXT BOOKS:

1. Principles of Management – P.C.Tripathi, P.N.Reddy – Tata McGraw Hill,
2. Dynamics of Entrepreneurial Development & Management – Vasant Desai – Himalaya Publishing House
3. Entrepreneurship Development – Poornima.M.Charantimath – Small Business Enterprises – Pearson Education – 2006 (2 & 4).

REFERENCE BOOKS:

1. Management Fundamentals – Concepts, Application, Skill Development – Robers Lusier – Thomson
2. Entrepreneurship Development – S.S.Khanka – S.Chand & Co.
3. Management – Stephen Robbins – Pearson Education/PHI – 17th Edition, 2003.

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

COMPUTER AIDED DESIGN AND MANUFACTURING

Course Code	**18MA52**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module 1 **INTRODUCTION**: Role of computers in design and manufacturing. Influence of computers in manufacturing environment. Product cycle in conventional and computerized manufacturing environment. Introduction to CAD, Introduction to CAM. Advantages and disadvantages of CAD and CAM	**8 Hours** **L1, L2**
Module 2 **HARDWARE FOR CAD & COMPUTER GRAPHICS**: Basic Hardware structure. Working principles, usage and types of hardware for CAD – Input devices, output devices, memory, CPU, hardcopy and storage devices. Software configuration of graphic system, function of graphics package, construction of geometry, wire frame and solid modeling, CAD/CAM integration. Desirable modeling facilities. Introduction to exchange of modeling data – Basic features of IGES, STEP, DXF, DMIS.	**8 Hours** **L1,L2**
Module 3 **INTRODUCTION TO FINITE ELEMENT ANALYSIS:** Introduction, basic concepts, discretization, element types, nodes and degrees of freedom mesh generation, constraints, loads, preprocessing, application to static analysis NC. CNC, DNC Technologies NC, CNC, DNC, modes, NC elements, advantages and limitations of NC, CNC. Functions of computer in DNC. **CNC TOOLING:** Turning tool geometry, milling tooling system, tool presenting, ATC, work holding.	**8 Hours** **L1,L2,L3**
Module 4 **CAM PROGRAMMING:** Overview of different CNC machining centers, CNC turning centers, high speed machine tools, MCE. **CNC PROGRAMMING**: Part program fundamentals-steps involved in development of part program. Manual part programming, milling, turning, turning center programming.	**8 Hours** **L1,L2,L3**
Module 5 **INTRODUCTION TO ROBOTICS**: Introduction, robot configuration, robot motion, programming of robots, end effectors, control, robot applications.	**8 Hours L1,L2,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	To gain the knowledge of Role of computers in design and manufacturing, Product cycle and the different types Input devices, output devices
CO2	Understanding basic concepts of finite element analysis, concepts of robotics, Machining Centers
CO3	To Compare the NC and CNC tooling and NC, CAM and CNC programming

Text Books:

1. CAD/CAM Principles and Application - P.N. Rao, Tata McGraw Hill.
2. CAD/CAM - Groover& Zimmers, PHI, 2003

Reference Book:

1. NC Machine Programming and software Design – ChnoHwachang, Michel. A. Melkanoff, Prentice Hall, 1989.
2. CAD/CAM - Ibrahim Zeid, Tata McGraw Hill, 2014.

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

METAL FORMING

Course Code	**18MA53**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module 1 **INTRODUCTION:** Classification of metal working processes, characteristics of wrought products, Advantages and limitations of metal working processes. **CONCEPTS OF TRUE STRESS & TRUE STRAIN**: Triaxial & biaxial stresses. Principal stresses, Tresca & vonmises yield criteria. **CONCEPTS OF PLANE STRESS & PLANE STRAIN**: Brief description of methods of metal deformation analysis. Effects of temperature, strain rate, friction and lubrication, hydrostatic pressure in metal working, Deformation zone geometry, workability of materials.	**8 Hours** **L1, L2**
Module 2 **FORGING:** Classification of forging processes. Forging machines and equipment. Expressions for forging pressures & load in open die forging and closed die forging by slab analysis, concepts of friction hill and factors affecting it, Die-design parameters. Material flow lines in forging. Forging defects, Residual stresses in forging. **ROLLING:** Classification of Rolling processes. Types of rolling mills, expression for Rolling load. Roll separating force. Frictional losses in bearing etc, power required rolling, Effects of front & back tensions, frictions, Roll diameter on rolling load, friction hill. Maximum possible reduction. Defects in rolled products.	**8 Hours** **L1,L2,L3**
Module 3 **DRAWING & EXTRUSION:** Drawing equipment & dies expression for drawing loads by slab analysis power requirement. Redundant work and its estimation, optimal cone angle & dead zone formation. Types of extrusion processes, extrusion equipment & dies, deformation, lubrication & defects in extrusion, extrusion of seamless pipes & tube.	**8 Hours** **L1,L2,L3**
Module 4 **SHEET METAL FORMING & DEEP DRAWING**: Forming methods dies & punches progressive die, compound die, combination die. Rubber forming, Open back inclinable press (OBI press), piercing & blanking, bending, stretch forming, Roll bending & contouring. Principles, stresses & deformation in drawn up. Die & punch design parameters. Total punch load, limiting drawing ratio. Effect of anisotropy on LDR, forming limit criteria & diagrams. Defects in deep drawn products.	**8 Hours** **L1,L2,L3**
Module 5 **POWDER METALLURGY & HIGH ENERGY RATE FORMING METHODS**: Basic steps in powder metallurgy, Brief description of methods of production of metal powders, conditioning & blending of powders, compaction & sintering applications of powder metallurgy components. Principles, advantages & applications. Explosive forming, Electro hydraulic forming, electromagnetic forming.	**8 Hours** **L1,L2**

Course Outcomes: After studying this course, students will be able to:

CO1	Classify the different processes in metal forming.
CO2	Describe the different types of metal forming process and its parameter.
CO3	Adapt to make use of suitable stresses to cause plastic deformation in different metal forming processes like forging, rolling, drawing, extrusion, sheet metal, PM & HERF.

TEXT BOOKS:

1. Materials and Processes in Manufacturing - E.Paul, Degramo, J.T.Black, Ronald, A.K. Prentice-Hall of India 2002
2. Manufacturing Engg., & Technology - Serope Kalpakjain and Stevan.R.Schmid, Pearson Education Asia, 4th Edi. 2002.

REFERENCE BOOKS:

1. 1 Deformation processing - W.A.Backofen, Addissen Weslay, 1973
2. Principles of Industrial Metal working process – G.W.Rowe, CBS Pub 2002.

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

ELEMENTS OF MACHINE DESIGN

Course Code	**18MA54**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:2:0	SEE Marks	60
Total Number of Hours	50	Exam. Hours	03

Number of Credits: 4

Content	**Hours/RBT Level**
Module 1 **DESIGN FOR STATIC STRENGTH & IMPACT LOADING:** Design consideration: codes and Standards, Static strength; Static loads and factor of safety; Theories of failure – Maximum normal stress theory, maximum shear stress theory, Distortion energy theory; Failure of brittle materials, failure of ductile materials. Stress concentration, Determination of Stress concentration factor. Combined Stress concentration factor. Derivation of instantaneous stress due to axial, bending loading, effect of inertia.	**10 Hours** **L1, L2, L3**
Module 2 **DESIGN FOR FATIGUE STRENGTH & DESIGN OF SHAFTS** Introduction, S – N diagram, Low cycle fatigue, High cycle fatigue, Endurance limit. Modifying factors –size effect, surface effect, Stress concentration effects; fluctuating stresses, Fatigue Strength under fluctuating stresses, Goodman and Soderberg relationship; Stress due to combined loading, cumulative fatigue damage. Torsion of shafts, design for strength & rigidity, with steady loading, ASME & BIS codes for design of transmission shafting, shafts under fluctuating loads and combined loads.	**10 Hours** **L1,L2,L3,L4**
Module 3 **DESIGN OF GEARS:** Spur Gears: Definitions, stresses in gear tooth, Lewis equation, form factor, Design for strength, dynamic and wear load. Bevel Gears: Definitions, formative number of teeth, design for strength, dynamic and wear load.	**10 Hours** **L1,L2,L3,L4**
Module 4 **COTTER JOINT & KNUCKLE JOINTS, KEYS AND COUPLINGS:** Design for cotter and knuckle joints, Keys: types of keys, design of keys. Design of coupling: Design of rigid flange coupling & bushed pin type flexible coupling Rigid and Flexible couplings: Flange coupling, Bush and pin type coupling.	**10 Hours** **L1,L2,L3,L4**
Module 5 **LUBRICATION AND BEARINGS:** Mechanisms of Lubrication – Viscosity, bearing modulus, coefficient of friction, minimum oil film thickness-Heat Generated, Heat dissipated, bearing materials, lubricants and properties. Examples of journal bearing and thrust bearing design, Ball and Roller Bearings: Bearing life, equivalent bearing load, selection of bearings of different types.	**10 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Understand basic of Mechanical Design procedure, material properties and selection of material, codes and standards, able to understand theories of failure, able to understand stress concentration factor, study about lubrication and bearings
CO2	Design machine components with and without geometric discontinuities Courseed to static, impact and fatigue load, a component having.
CO3	Analyze the stress level and deformation in the different parts of the machine components.
CO4	Determine the life of components Courseed to various loads.

Text Books:

1. Mechanical Engineering design-Joseph Edward Shigley, Tata McGraw Hill, New Delhi 1986
2. Design of Machine Elements – V.B. Bhandri, - Tata McGraw Hill Publishing Co. Ltd., New- Delhi.

Reference Book:

1. Machine Design – R. K. Jain, Khanna Publications, New Delhi.
2. Elements of Machine Design, H G Patil et. al, IK International, 2019

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

STATISTICAL QUALITY CONTROL

Course Code	**18MA55**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	**Hours/RBT Level**
Module 1 **INTRODUCTION:** Definition of Quality, Quality Dimensions, Inspection and Quality control, Quality Assurance – Quality planning, Quality costs – Economics of quality, Quality loss function.	**8 Hours** **L1, L2, L3**
Module 2 Introduction to Control charts, Construction and application. Chance and assignable causes of process variation, Statistical basis of the control chart for variable, Attribute control charts - p, n np,c and u charts.	**8 Hours** **L1,L2,L3,L4**
Module 3 Warning and Modified Control Limits. Control Chart for Individual Measurements, Multi-Variable Chart, X – Chart with a Linear Trend, Charts for moving average and ranges, Cumulative-Sum and Exponentially, Weighted Moving Average Control Charts.	**8 Hours** **L1,L2,L3,L4**
Module 4 Process Stability. Analysis using a Histogram, Probability Plots and control Chart, Gauge capability studies, Process Capability.	**8 Hours** **L1,L2,L3,L4**
Module 5 Acceptance Sampling Fundamental, OC Curves, Sampling Plans for Attributes, Signal and double sampling plans, Multiple and Sequential sampling plans, Sampling plans for variables- MIL-STD-105D standards.	**8 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to

CO1	Explains the basic concept of Quality, Control Charts and Acceptance Sampling
CO2	Construct control charts and evaluate revised control limits
CO3	Analyze process capability and operating characteristic curves

Text Books:

1. 1.Douglas C Montgomery, Introduction to Statistical Quality Control, John Wiley, Seventh Edition, 2012.

Reference Book:

1. Grant E.L. and Leavenworth, Statistical Quality Control, TMH, 2000. IS 2500 Standard sampling plan

2.

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

Operations Research

Course Code	**18MA56**	CIE Marks	40
Number of Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Total Number of Hours	50	Exam. Hours	03

Number of Credits: 4

Content	**Hours/RBTLevel**
Module 1 **Introduction:** Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).	**10 Hours** **L1, L2, L3**
Module 2 **LPP:** Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and Two Phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.	**10 Hours** **L1,L2,L3,L4**
Module 3 **Transportation Problem:** Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution(MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem. **Assignment Problem**: Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Numerical Problems.	**10 Hours** **L1,L2,L3,L4**
Module 4 **Network analysis:** Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks, PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems. **Queuing Theory:** Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.	**10 Hours** **L1,L2,L3,L4**
Module 5 **Game Theory:** Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games. **Sequencing:** Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.	**10 Hours** **L1,L2,L3,L4**

Course Outcome: After studying this course, students will be able to:

CO-1	Define terminologies and procedures associated with different Operations Research techniques.
CO-2	Describe the importance, Characteristics and limitations of OR techniques.
CO-3	Apply OR technique/strategies to solve industrial and managerial related problems.
CO-4	Allocate and schedule the resources and optimum cost and time.
CO-5	Enables to review and evaluate project duration and Critical path.

Text Books:

1. Operations Research, P K Gupta and D S Hira, S. Chand and Company LTD. Publications, New Delhi – 2007
2. Operations Research, An Introduction, Seventh Edition, Hamdy A. Taha, PHI Private Limited, 2006.

Reference Books:

1. Operations Research, Theory and Applications, Sixth Edition, J K Sharma, Trinity Press, Laxmi Publications
   Pvt.Ltd. 2016.
2. Operations Research, Paneerselvan, PHI.
3. Operations Research, A M Natarajan, P Balasubramani, Pearson Education, 2005
4. Introduction to Operations Research, Hillier and Lieberman,8thEd., McGraw Hill

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

COMPUTER AIDED DESIGN AND MANUFACTURING LAB

Course Code	**18MAL57**	CIE Marks	40
Number of Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Total hours/Week	40	Exam Hours	03

No. of Credits: 2

Content	**Hours/RBT Level**
PART – A Modelling and simulation of Machining process of simple machine parts using CAM packa models.	**20** **L1, L2 ,L3**
PART – B Using finite element package analyse bar, tapered bar, truss, beams with concentrated and distributed loads for deformation strains and stresses.	**20** **L1, L2 ,L3**

Course Outcomes: On completion of this Course students will be able to:

CO1	Understand the codes for CAM packages, and FEM package for analysis
C02	Simulate the machining operation using CAM package
CO3	Analyse the structural members for deformations, strains and stresses

Text Books:

1. CAD/CAM Principles and Application - P.N. Rao, Tata McGraw Hill.
2. CAD/CAM - Groover& Zimmers, PHI, 2003

Reference Book:

1. CAD/CAM Ibrahim Zeid, Tata McGraw Hill, 2014.
2. NC Machine Programming and software Design – ChnoHwachang, Michel. A. Melkanoff, Prentice Hall, 1989.
3. Numetical control and CAM - Pressman RS and Williams JE, Johnwiley.

Scheme of Examination:

One Model from Part – A : 40 Marks
One Model from Part – B : 40 Marks
Viva – Voce :20 Marks
Total : 100 Mark

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - V

WORKSHOP AND MACHINE SHOP PRACTICE

Course Code	**18MAL58**	CIE Marks	40
Number of Hours / Week (L:T:P)	04	SEE Marks	60
Total Number of hours	40	Exam Hours	03

No. of Credits: 2

Content	**No. of Hours/RBT**
Part A Preparation of at least two fitting joint models	**10 Hours** **L1, L2, L3, L4**
Part B Preparation of three models on lathe involving - Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning. Exercises should include selection of cutting parameters and cutting time estimation.	**15 Hours** **L1, L2, L3, L4**
Part C Welding: Study of electric arc welding tools & equipments, Models: Butt Joint, Lap Joint Sheet Metal & Soldering Work: Development & Soldering of the models: Frustum of cone, Truncated Square Pyramid	**15 Hours** **L1, L2, L3, L4**

Course Outcomes: On completion of this Course students will be able to:

CO1	To read working drawings, understand operational symbols and execute machining operations.
CO2	Prepare fitting models according to drawings using hand tools- V-block, marking gauge, files, hack saw, drills etc.
CO3	Understand integral parts of lathe, shaping and milling machines and various accessories and attachments used thereof.
C04	Select cutting parameters like cutting speed, feed, depth of cut, and tooling for various machining operations.
CO5	Perform cylindrical turning operations such as plain turning, taper turning, step turning, thread Cutting, facing, knurling, internal thread cutting, eccentric turning and estimate cutting time.

REFERENCE TEXT BOOKS:

1. Elements of Workshop Technology: Volume I:Manufacturing Processes, S K Hajra. Choudhury, A K. Hajra Choudhury,15th Edition Reprinted 2013,Media Promoters &Publishers Pvt Ltd., Mumbai.
2. Strength of Materials, Rajput R. K., 2007 Edition.
3. Callister's Materials Science and Engineering, R. Balasubhramanaim, 2 Edition, 2014

Scheme of Examination:

One Model from Part-A or Part-C	30 Marks
One Model from Part-B	50 Marks
Viva – Voce	20 Marks
TOTAL	100 Marks

B. E. COMMON TO ALL PROGRAMMES
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER – V

ENVIRONMENTAL STUDIES

Course Code	**18CIV59**	CIE Marks	40
Teaching Hours / Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

Module - 1

Ecosystems (Structure and Function): Forest, Desert, Wetlands, Riverine, Oceanic and Lake.
Biodiversity: Types, Value; Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

Module - 2

Advances in Energy Systems (Merits, Demerits, Global Status and Applications)**:** Hydrogen, Solar, OTEC, Tidal and Wind.
Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

Module - 3

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies)**:** Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.
Waste Management & Public Health Aspects: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

Module - 4

Global Environmental Concerns (Concept, policies and case-studies): Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

Module - 5

Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs.
Field work: Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be Followed by understanding of process and its brief documentation.

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

- CO1: Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale,
- CO2: Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
- CO3: Demonstrate ecology knowledge of a complex relationship between biotic and abiotic components.
- CO4: Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

Question paper pattern:

- The Question paper will have 100 objective questions.
- Each question will be for 01 marks
- Student will have to answer all the questions in an OMR Sheet.
- The Duration of Exam will be 2 hours.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Environmental Studies	Benny Joseph	Tata Mc Graw – Hill.	2nd Edition, 2012
2.	Environmental Studies	S M Prakash	Pristine Publishing House, Mangalore	3rd Edition, 2018

3	Environmental Studies – From Crisis to Cure	R Rajagopalan	Oxford Publisher	2005
Reference Books				
1	Principals of Environmental Science and Engineering	Raman Sivakumar	Cengage learning, Singapur.	2nd Edition, 2005
2	Environmental Science – working with the Earth	G.Tyler Miller Jr.	Thomson Brooks /Cole,	11th Edition, 2006
3	Text Book of Environmental and Ecology	Pratiba Sing, Anoop Singh& Piyush Malaviya	Acme Learning Pvt. Ltd. New Delhi.	1st Edition

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SEMESTER - VI

NON DESTRUCTIVE TESTING

Course Code	**18MA61**	CIE Marks	40
Number of Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Total Number of Hours	50	Exam. Hours	03

Number of Credits: 4

Content	**Hours/RBT Level**
Module 1 **OVERVIEW OF NDT:** NDT Versus Mechanical testing, Overview of the Non Destructive Testing Methods for the detection of manufacturing defects as well as material characterisation. Relative merits and limitations, Various physical characteristics of materials and their applications in NDT., Visual inspection – Unaided and aided.	**10 Hours** **L1, L2, L3**
Module 2 **SURFACE NDE METHODS:** Liquid Penetrant Testing – Principles, types and properties of liquid penetrants, developers, advantages and limitations of various methods, Testing Procedure, Interpretation of results. Magnetic Particle Testing- Theory of magnetism, inspection materials, magnetization methods, Interpretation and evaluation of test indications, Principles and methods of demagnetization, Residual magnetism.	**10 Hours** **L1,L2,L3**
Module 3 **THERMOGRAPHY AND EDDY CURRENT TESTING (ET):** Thermography- Principles, Contact and non -contact inspection methods, Techniques for applying liquid crystals, Advantages and limitation – infrared radiation and infrared detectors, Instrumentations and methods, applications. Eddy Current Testing-Generation of eddy currents, Properties of eddy currents, Eddy current sensing elements, Probes, Instrumentation, Types of arrangement, Applications, advantages, Limitations, Interpretation/Evaluation.	**10 Hours** **L1,L2,L3**
Module 4 **ULTRASONIC TESTING (UT) AND ACOUSTIC EMISSION (AE):** Ultrasonic Testing-Principle, Transducers, transmission and pulse-echo method, straight beam and angle beam, instrumentation, data representation, A/Scan, B-scan, C-scan. Phased Array Ultrasound, Time of Flight Diffraction. Acoustic Emission Technique –Principle, AE parameters, Applications.	**10 Hours** **L1,L2,L3**
Module 5 **RADIOGRAPHY (RT):** Principle, interaction of X-Ray with matter, imaging, film and film less techniques, types and use of filters and screens, geometric factors, Inverse square, law, characteristics of films – graininess, density, speed, contrast, characteristic curves, Penetrameters, Exposure charts, Radiographic equivalence. Fluoroscopy- Xero-Radiography, Computed Radiography, Computed Tomography.	**10 Hours** **L1,L2,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	Classify various nondestructive testing methods.
CO2	Check different metals and alloys by visual inspection method.
CO3	Explain and perform non-destructive tests like: Liquid penetrant test, Magnetic particle test, Ultrasonic test, X-ray and Gamma ray radiography, Leak Test, Eddy current test.
CO4	Identify defects using relevant NDT methods.
CO5	Differentiate various defect types and select the appropriate NDT methods for better evaluation.
CO6	Document the testing and evaluation of the results.

Text Books:

1. "Practical Non-Destructive Testing", Baldev Raj, T.Jayakumar, M.Thavasimuthu Narosa Publishing House, 2009.
2. "Non-Destructive Testing Techniques", Ravi Prakash, 1st revised edition, New Age International

Publishers, 2010

Reference Book:

1. ,"Non-Destructive Evaluation and Quality Control", ASM Metals HandbookAmerican Society of Metals, Metals Park, Ohio, USA, 200, Volume-17.
2. "Introduction to Non-destructive testing: a training guide", Paul E Mix, Wiley, 2nd Edition New Jersey, 2005
3. ," Handbook of Nondestructive evaluation",Charles, J. Hellier McGraw Hill, New York 2001
4. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

COMPUTER INTEGRATED MANUFACTURING

Course Code	**18MA62**	CIE Marks	40
Number of Hours/Week (L:T:P)	4:0:0	SEE Marks	60
Total Hours	50	Exam Hours	03

No. Of Credits:4

Content	**Hours/RBT Level**
Module 1 **INTRODUCTION:** brief introduction to CAD and CAM – manufacturing planning, manufacturing control- introduction to CAD/CAM – concurrent engineering- CIM concepts – computerized elements of CIM system –types of production – manufacturing models and metrics – mathematical models of production performance – simple problems – manufacturing control – simple problems – basic elements of an automated system – levels of automation – lean production and just-in-time production.	**10 Hours** **L1, L2, L3**
Module 2 **PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING:** Process planning – computer aided process planning (CAPP) – logical steps in computer aided process planning – aggregate production planning and the master production schedule – material requirement planning – capacity planning- control systems-shop floor control-inventory control – brief on manufacturing resource planning-ii (MRP2) & enterprise resource planning (ERP) – simple problems.	**10 Hours** **L2, L3, L4**
Module 3 **CELLULAR MANUFACTURING:** Group technology(GT), part families – parts classification and coding – simple problems in Opitz part coding system – production flow analysis – cellular manufacturing – composite part concept – machine cell design and layout – quantitative analysis in cellular manufacturing – rank order clustering method – arranging machines in a GT cell – Hollier method – simple problems.	**10 Hours** **L1, L2, L3, L4**
Module 4 **FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE SYSTEM (AGVS):** Types of flexibility – FMS – FMS components – FMS application & benefits – FMS planning and control– quantitative analysis in FMS – simple problems. Automated guided vehicle system (AGVs) – AGVs application – vehicle guidance technology – vehicle management & safety.	**10 Hours** **L2, L3, L4**
Module 5 **INDUSTRIAL ROBOTICS:** Robot anatomy and related attributes – classification of robots- robot control systems – end effectors – sensors in robotics – robot accuracy and repeatability – industrial robot applications – robot part programming – robot accuracy and repeatability	**10 Hours** **L2, L3, L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Define Automation, CIM, CAD, CAM and explain the differences between these concepts. Solve simple problems of transformations of entities on computer screen.
CO2	Explain the basics of automated manufacturing industries through mathematical models and analyze different types of automated flow lines.
CO3	Able to apply mathematical models and metrics for automated manufacturing industries.

TEXT BOOKS:

1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 4th Edition, 2015, Pearson Learning.
2. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata McGraw-Hill.
3. "Introduction to Robotics: Mechanics And Control", Craig, J. J., 2nd Ed., Addison-Wesley Publishing Company, Readong, MA, 1989.

REFERENCE BOOKS:

1. “CAD/CAM” by Ibrahim Zeid, Tata McGraw Hill, 2014.
2. “Computer Automation in Manufacturing”, Boucher, T. O., Chapman & Hall, London, UK, 1996.
3. CAD/CAM/CIM, Dr. P. Radhakrishnan, 3rd edition, New Age International Publishers, New Delhi.

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

ADDITIVE MANUFACTURING

Course Code	**18MA63**	CIE Marks	20
Number of Hours/Week (L:T:P)	4:0:0	SEE Marks	80
Total Number of Hours	50	Exam. Hours	03

Number of Credits: 4

Content	**Hours/RBT Level**
Module 1 **INTRODUCTION TO ADDITIVE MANUFACTURING & CLASSIFICATION OF AM PROCESSES**: Introduction to AM, AM evolution, Distinction between AM & CNC machining, Advantages of AM. Liquid polymer system, discrete particle system, molten material systems, solid sheet system	**10 Hours** **L1, L2**
Module 2 **AM PROCESS CHAIN:** Conceptualization, CAD, conversion to STL, Transfer to AM, STL file manipulation, Machine setup, build , removal and clean up, post processing.	**10 Hours** **L1,L2**
Module 3 **DESIGN FOR AM:** Motivation, DFMA concepts and objectives, AM unique capabilities, Exploring design freedoms, Design tools for AM, Part Orientation, Removal of Supports, Hollowing out parts, Inclusion of Undercuts and Other Manufacturing Constraining Features, Interlocking Features, Reduction of Part Count in an Assembly, Identification of markings/ numbers etc.	**10 Hours** **L1,L2**
Module 4 **GUIDELINES FOR PROCESS SELECTION&INTRODUCTION**: selection methods for a part, challenges of selection, example system for preliminary selection, production planning and control. **POST PROCESSING OF AM PARTS:** Support material removal, surface texture improvement, accuracy improvement, aesthetic improvement, preparation for use as a pattern, property enhancements using non-thermal and thermal techniques.	**10 Hours** **L1,L2,L3**
Module 5 **AM APPLICATIONS:** Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Remanufacturing. Application examples for Aerospace, defense, automobile, Bio-medical and general engineering industries.	**10 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Identify the additive manufacturing techniques and processes.
CO2	Summarize the AM process chain and guidelines for process selection.
CO3	Describe the post processing of AM parts, design for AM and AM applications.

Text Books:

1. Stereo lithography and other RP & M Technologies - Paul F. Jacobs - SME, NY 1996.
2. Rapid Manufacturing - Flham D.T & Dinjoy S.S - Verlog London 2001.
3. Rapid automated - Lament wood - Indus press New York.

Reference Book:

1. Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

TOOL ENGINEERING

Course Code	**18MA641**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Hours	40	Exam Hours	03

No. of Credits: 3

Content	Hours/RBTLevel
Module 1 **Introduction to tool design:** Tooling, requirements of a tool designer, general tool design procedure, tool engineering functions and its importance to enhance productivity and quality. Review of cutting tool materials. Tool angles and signature, Carbide inserts grades - ISO designation and applications, tool holders for turning-ISO designation. Solid type tool, brazed tip tool, throwaway indexable insert types, coated carbides and chip breakers. **Design of single point cutting tools:** Design of shank dimensions using strength and rigidity considerations for rectangular, square and round cross section and selection of tool geometry.	**8 Hours** **L1, L2, L3**
Module 2 **Design of Multi Point Cutting Tools:** Types of drills, Drillbit design-elements like back taper, web thickness, land width, margin, flute length and cross section and selection of tool geometry. Re-sharpening of drillbit. Tool holders for milling, different tapers used for mounting tool holders in milling, ISO designation. Tool mounting systems. **Design of milling cutters:** Design of elements like number of teeth and height, circular pitch, body thickness, chamfer width, fillet radius and selection of tool geometry. Profile sharpened and form relieved milling cutters. Re-sharpening of side and face milling cutter and end mill.	**8 Hours** **L2, L3, L4**
Module 3 **Jigs and Fixtures:** 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, and power clamping. Drill bushes; Drill jigs: different types, exercises of designing jigs for simple components. **Fixture Design:** Turning fixtures, milling fixtures, grinding fixtures, fixturing for CNC machining centers, and modular fixtures. Design exercises on fixtures for turning and milling for simple components.	**8 Hours L2, L3, L4**
Module 4 **Press tools:** Classification and working of power presses. Concept and calculations of press tonnage and shut height of a press, components of a simple die, press tool operation, die accessories, shearing action in punch & die, clearance, shear on punch and die, Centre of pressure, and strip layout. Simple, progressive, compound, combination and inverted dies. Design problems on blanking and piercing dies for simple components. **Bending dies** – Introduction, bend allowance, spring back, edge bending die design.	**8 Hours** **L2, L3, L4**
Module 5 **Drawing dies –** Single action, double action and triple action dies, factors affecting drawing and drawing die design. Design of drawing dies for simple components. **Die casting:** Die casting alloys, terminology- core, cavity, sprue, slug, fixed and movable cores, finger cams, draft, ejector pins and plates, gate, goose nozzle, over- flow, platten, plunger, runner, vent, water-line etc. **Types of Dies**: Single cavity, multi cavity dies, combination dies, unit dies, advantages and disadvantages of types of dies; finishing, trimming and inspection of die casting components, safety, and modern trends in die casting dies.	**8 Hours** **L2, L3, L4**

Course Outcomes: After learning the course the students should be able to:

CO1	Understand various press tools and press tool operations.
CO2	Understand cutting tool and tool holder designation systems.
CO3	Select appropriate cutting tools required for producing a component.
CO4	Select suitable locating and clamping devices for a given component for various operations.
CO5	Classify and explain various die casting and injection moulding dies.
CO6	Analyze and design a jig/fixture for a given simple component.

Textbooks:

1. Cyril Donaldson, George H. Lecain, V.C. Goold, "Tool Design", Mc Graw Hill Education, 5th edition, 2017.
2. P.N. Rao, "Manufacturing technology", Mc Graw Hill Education, 4th edition,2013

References:

1. P.H. Joshi, "Jigs and Fixtures", Mc Graw Hill Education, 3rd edition,2010.
2. John.G. Nee, William Dufraine, John W. Evans, Mark Hill, "Fundamentals of Tool Design", Society of Manufacturing Engineers, 2010.
3. Kempester M.H.A., "An introduction to Jig and Tool design", VIVA Books Pvt. Ltd.,2004

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

Machine Tool Design

Course Code	**18MA642**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/ RBT level
Module 1 **PRINCIPLES OF MACHINE TOOL DESIGN, DRIVES and MECHANISMS:** General requirements of machine tool design - design process machine tool layout, Drives: Electric drives, Hydraulic drives structure, Regulation of speed and feeds, stepped regulation, standardization of speed and feed, step less regulation of speeds and feeds.	**10Hrs** **L1,L2,L3**
Module 2 **CUTTING FORCE ANALYSIS AND POWER REQUIREMENT:** In Turning, Milling, Drilling, Shaping and Broaching operation with simple problems. General requirements of machine tools - Centre lathe, Milling machine.	**06Hrs** **L1,L2**
Module 3 **DESIGN OF MACHINE TOOL STRUCTURES, GUIDE WAYS AND POWER SCREWS:** Functions-Requirements-Design criteria Material used – static and dynamic stiffness – Profile and basic design procedure for machine tool structures. Design of beds, columns, housing, bases, tables cross-rails, arms saddle, carriages.	**08Hrs** **L2,L3**
Module 4 **DESIGN OF SPINDLE AND SPINDLE BEARINGS:** Functions-Requirements and materials for spindle compliance and machining accuracy. Design of spindles, antifriction bearing, Hydrodynamic and Hydrostatic bearing, Air lubricated bearing.	**08Hrs** **L2,L3**
Module 5 **DYNAMICS OF MACHINE TOOLS:** Concept of dynamic cutting process, Physical causes of chatter and vibrations, Types of Chatter. Stability chart, chatter vibration in Lathe, Drilling machine, Grinding machine and Milling machine. Different methods for avoiding machine tool chatter and vibration.	**08Hrs.** **L2,L3**

Course Outcomes: The student on completion of the course will be able to:

CO1	Understand the structure of machine tools, and drives therein.
CO2	Estimate the cutting forces in machining.
CO3	Design the static structure of the machine tool.
CO4	Design the spindles and choose supporting elements.
CO5	Identify the dynamic signature of the machine tool in operation.

Text Books:

1. Machine Tool Design, N.K. Mehta, 2nd Ed., Tata McGraw Hill 2001.
2. Principles of Machine Tools, Sen and Bhattacharaya Oxford IBM, Publishing 2000

Reference Books:

1. Machine Tool Design Volume – II and III, N. Acharkan MIR Publications 2000.
2. Design of Machine Tools, S. K. Basu and D. K. Pal 2000.
3. Principles of Machine Tool Design, Koensberger 1993.

B. E. MANUFACTURING SCIENCE AND ENGINEERING
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - VI

MAINTENANCE ENGINEERING

Course Code	**18MA643**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBTLevel
Module 1 **INTRODUCTION TO MAINTENANCE SYSTEM:** Definition, Scope, Objective, functions and Importance of maintenance system, Type of maintenance system, Break down maintenance system, Preventive maintenance, Predictive maintenance, design out maintenance, corrective maintenance, planned maintenance, total productive maintenance, condition monitoring. Problems on selection of methods like preventive or breakdown maintenance.	**8 Hours** **L1, L2**
Module 2 **ECONOMICS IN MAINTENANCE:** Repair, replacement, Repair complexity, Finding out most optimal preventive maintenance frequency. Numerical treatment required.	**8 Hours** **L1,L2,L3**
Module 3 **MAINTENANCE OF MACHINERY:** Causes of machine failure, performance evaluation, complete overhauling of Machines tools. Maintenance planning and scheduling. Repair order control manpower requirement, Maintenance job analysis spare parts control. **MAINTENANCE PLANNING:** Planning of maintenance junctures manpower allocation, Long range planning, short range planning. Planning techniques and procedures. Estimation of maintenance work. Maintenance control.	**8 Hours** **L1,L2,L3**
Module 4 **INDUSTRIAL SAFETY:** Economic importance of accidents, Types of safety organizations, Analysis of accident records, accident investigations, Analysis of accident Safety standards for Mechanical equipment. **SAFETY STANDARDS:** Safety standards for Electrical equipment and systems. Chemical hazards, material handling, exhaust systems, welding, Plant housekeeping-building, Aisles, passages, floors, tool cribs, washrooms, canteens.	**8 Hours** **L1,L2,**
Module 5 **COMPUTERS IN MAINTENANCE:** Features and benefits of Computer aided maintenance. Application of computers to maintenance work. **INDUSTRIAL POLLUTION CONTROL:** Dust control –Fiber collectors, mechanical dust collectors, wet type collectors, Electro static precipitators, Noise pollution Control – Noise measurement and control. Industrial vibration and its control.	**8 Hours** **L1,L2,**

Course Outcomes: After studying this course, students will be able to:

CO1	Understand the concept s and types of maintenance engineering.
CO2	Analyze the economics of maintenance activities.
CO3	Identify the causes of machine failure and estimate the maintenance work.
CO4	Outline the industrial safety, safety standards and pollution control.
CO5	Make use of computers in maintenance.

Text Books:

1. Maintenance Engineering and Management - R.C.Mishra and K.Pathak, Prentice Hall of India, 2002
2. Maintenance Engineering Hand book - Morrow.

Reference Book:

1. Industrial Pollution Control Handbook - LUND
2. Industrial Maintenance - H P Garg
3. Maintenance Engineering Hand book - Lindrey Higgins, McGraw Hill, 6th edition, 2003

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SEMESTER - VI

AUTOMATION AND ROBOTICS

Course Code	**18MA651**	CIE Marks	40
Number of Hours/Week (L:T:P)	3L	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBTLevel
Module 1 **Automation:** History of automation, Advantages and disadvantages of automation. Types of automation – fixed, programmable and flexible automation, Automation strategies, Automated production lines and its applications. Automatic identification – barcode technology and radio frequency identification. **Automated manufacturing systems:** Components, Classification and overview of manufacturing systems, Flexible Manufacturing Systems (FMS), Types of FMS, Applications and benefits of FMS.	**8 Hours (L1, L2, L3)**
Module 2 **INTRODUCTION TO ROBOTICS:** Definition of robot, History of robotics, Robot anatomy, Robot configurations: polar, cartesian, cylindrical and jointed-arm configuration, Robot motions, joints, and work volume, Robot drive systems, Precision of movement – spatial resolution, accuracy, repeatability, end effectors – tools and grippers, Asimov's laws of robotics. **Spatial descriptions:** Positions, orientations and frames, Changing descriptions from frame to frame, Operators: translations, rotations and transformations.	**8 Hours (L1, L2, L3, L4)**
Module 3 **Controllers:** Basic control system concepts and models, Transfer functions, Block diagrams, Characteristic equation, Types of controllers: on-off, proportional, integral, differential, P-I, P-D, P-I-D controllers. **Robot actuation and feedback components:** Position sensors – potentiometers, resolvers, encoders, and velocity sensors, Actuators – pneumatic and hydraulic actuators, electric motors, stepper motors, servomotors, power transmission systems.	**8 Hours (L1, L2, L3, L4)**
Module 4 **Sensors:** Tactile sensors, Proximity and range sensors, Use of sensors in robotics. **Machine vision system:** Introduction to machine vision, Sensing and digitizing function in machine vision, Image processing and analysis, Training and vision systems.	**8 Hours (L1, L2, L3, L4)**
Module 5 **Robotic technology of the future:** Robot Intelligence, Advanced sensor capabilities, Telepresence, Mechanical design features, Mobility, Locomotion and navigation, Universal hand **Artificial Intelligence:** Goals of AI research, AI techniques – Knowledge representation, problem representation and problem solving, Levels of robot programming, Requirements of robot programming language, LISP programming.	**8 Hours (L1, L2, L3, L4)**

Course outcomes: After studying this course, students will be able to:

CO1	Understand the role of automation and Flexible Manufacturing Systems (FMS) in manufacturing.
CO2	Explain robotic configurations and controllers and actuation systems for robotic drive systems.
CO3	Explain different sensors and control systems.
CO4	Understand robotic technologies and robotic programming using AI.

Textbooks:

1. Robotics for Engineers –Yoram Koren, McGraw Hill International, 1st Edition, 1985.
2. Introduction to Robotics Mechanics and Control – John J. Craig, 3rd Edition, Pearson, 2009.

Reference books:

1. Industrial Robotics – Groover, Weiss, Nagel, McGraw Hill International, 2nd Edition, 2012.
2. Robotic Engineering – An Integrated Approach, Klafter, Chmielewski and Negin, Phi, 1st Edition, 2009.

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SEMESTER - VI

Knowledge Management

Course Code	**18MA652**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits:3

Content	Hours/RBTLevel
Module 1 **KNOWLEDGE INFLUENCES: INTRODUCTION:** External influences on organizations, Changing nature of management, Types of organizations, Strategic management in organizations, Knowledge management, Knowledge management an emerging concept, Model of strategic knowledge management. **INTRODUCTION TO KEY CONCEPTS:** What is Management? Knowledge Management and business strategies, Knowledge intensive firms and Knowledge workers, Learning and Knowledge Management.	**8Hrs** **L1,L2**
Module 2 **KNOWLEDGE CREATION AND LOSS:** Innovation dynamics and knowledge processes, characterizing innovation processes, innovation as an interactive process, knowledge creation and Nonaka, the social dynamics of innovation networking processes, forgetting and unlearning knowledge. **DEVELOPING AND MANAGING KNOWLEDGE REPOSITORIES:** Effective knowledge repositories, mapping the content structure, repository quality control, case studies (not for examination)	**10Hrs** **L1,L2,L3**
Module 3 **DESIGN KNOWLEDGE MANAGEMENT SYSTEM:** Introduction, Structure preserving design, Step 1: design system architecture, Step 2: identify target implementation platform, Step 3: specify architectural components, Step 4: specify application within architecture, design of prototypes, distributed architecture. **SOCIO-CULTURAL ISSUES:** Introduction, significance of cross community knowledge processes, characterizing cross community knowledge processes, identity, knowledge, trust and social relations, classification of boundary types, facilitating/managing knowledge between communities.	**10Hrs** **L2,L3**
Module 4 **KNOWLEDGE LEADERSHIP:** Introduction, contributions of disciplines to Knowledge Leadership, the generic attributes of knowledge leader, specific knowledge leadership roles, leading knowledge teams, leading a knowledge network, recruiting and selecting knowledge leaders.	**06Hrs** **L2,L3**
Module 5 **INFORMATION AND COMMUNICATION TECHNOLOGIES ANDKNOWLEDGE MANAGEMENT:** Introduction, linking knowledge management and ICTs, objectivist perspectives on ICT – enabled knowledge management, practice based perspectives on ICT enabled KM, the importance of accounting for socio cultural factors in ICT enabled KM, debates regarding the role of ICTs in KM processes.	**06 Hrs.** **L2**

Course Outcomes: The student on completion of the course will be able to:

CO1	Understand the links between Knowledge Management, organizational learning, innovation and creativity.
CO2	Analyse the fundamental elements of Knowledge Management.
CO3	Examine and evaluate how leadership can be used to facilitate a human infrastructure to diffuse knowledge and enable best practice.
CO4	Apply Knowledge Management objectives in projects across diverse fields.

CO5	Identify the drivers and inhibitors of effective Knowledge Management practices to promote innovation.

Text Books:

1. Knowledge Management, Shelda Debowski, Wiley India, 2007.
2. Knowledge Management in Organizations, Donald Hislop, 2nd Ed., Oxford Universities Press, 2009

Reference Books:

1. Knowledge Engineering and Management, Guus Schreiber, et al, Universities Press India Pvt. Ltd., 2003
2. Knowledge Management - Classic and contemporary works, Daryl Morey, et. al., 2007

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SEMESTER - VI

NON DESTRUCTIVE TESTING LABORATORY

Course Code	**18MAL66**	CIE Marks	40
Number of Hours/Week (L:T:P)	0:2:2	SEE Marks	60
Total hours	40	Exam Hours	03

No. of Credits: 2

Course Learning Objective:
To provide the knowledge on types, working principles and advantages of NDT. To enable the students to choose the NDT procedure for a given part.

Content	Hours/RBT Level
1. Visual inspection. 2. Radiography. 3. Liquid (Dye) penetrant method. 4. Magnetic particles. 5. Eddy current testing. 6. Ultrasonic Inspection. 7. Acoustic Method.	**40** **L1, L2, L3**

Course Outcomes After studying this course, students will be able to:

CO1	Understand the non-destructive testing method to be used based on testing material
CO2	Conduct the NDT by various methods
CO3	Identify the defects on the surface and core.

Text Books:

1. Practical Non-Destructive Testing, Baldev Raj, T. Jayakumar, M. Thavasimuthu Narosa Publishing House, 2009.
2. Non-Destructive Testing Techniques, Ravi Prakash, 1st revised edition, New Age International Publishers, 2010

Reference Book:

1. Handbook of Nondestructive evaluation Charles, J. Hellier, McGraw Hill, New York 2001
2. ASNT, American Society for Non Destructive Testing, Columbus, Ohio, NDT Handbook,Vol. 1, Leak Testing, Vol. 2, Liquid Penetrant Testing, Vol. 3, Infrared and Thermal Testing Vol. 4, Radiographic Testing, Vol. 5, Electromagnetic Testing, Vol. 6, Acoustic Emission Testing, Vol. 7, Ultrasonic Testing

Scheme of Examination:

One Model from Part – A : 50 Marks
One Model from Part – B : 30 Marks
Viva – Voce :20 Marks
Total : 100 Marks

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SEMESTER - VI

ADDITIVE MANUFACTURING LABORATORY

Course Code	**18MAL67**	CIE Marks	40
Number of Hours/Week (L:T:P)	0:2: 2	SEE Marks	60
Total hours	40	Exam Hours	03

No. of Credits: 2

Content	**Hours/RBTLevel**
PART – A Create part models using CAD packages and then export the models onto the 3D Printing machine and create the prototype. For example model individual parts of a Plummer block and assemble it once the all parts are completed. Create following parts: 1. Block Base 2. Hexagonal Nut 3. Bolts 4. Cap 5. Bearing top half 6. Bearing bottom half. Creation of Screw jack all part drawings Creation of Bench vice with all part drawings Creation of their own Product from requirement gathering to final product involves Creation of 3D Part Drawings	**20** **L1, L2 ,L3**
PARTB Conversion of 3D Part drawings to steriolithograhy (stl) format.	**10** **L1, L2 ,L3**
PARTC Generation of Additive Manufacturing Machine specific Code. Fabrication of model using Rapid Prototyping Machine.	**10** **L1, L2 ,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	Gain knowledge about the all Rapid Prototyping Process.
CO2	Understand the Material choice according to the application.
CO3	Fabricate the final physical model using Rapid Prototyping Machine.

Reference Text Books:

1. "Rapid Prototyping: Principles & Applications",Chua Chee Kai, Leong Kah Fai, World Scientific, 2003.
2. Computer Aided Manufacturing - P.N. Rao, N.K. Tewari and T.K. Kundra Tata McGraw Hill 1999.

Scheme of Examination:

One Model from Part – A : 50 Marks
One Model from Part – B : 30 Marks
Viva – Voce :20 Marks
Total : 100 Marks

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SEMESTER - VII

CONTROL ENGINEERING

Course Code	**18MA71**	CIE Marks	40
Number of Hours/Week (L:T:P)	2:2:0	SEE Marks	60
Credits	**03**	Exam. Hours	03

Content	**Hours/RBT Level**
Module 1 **Introduction:** Components of a control system, Open loop and closed loop systems. **Types of controllers:** Proportional, Integral, Differential, Proportional-Integral, and Proportional- Integral-Differential controllers. **Modeling of Physical Systems :** Mathematical Models of Mechanical, Electrical, Thermal, Hydraulic Systems.	**10Hrs** **L1,L2,L3**
Module 2 **Time domain performance of control systems:** Typical test signal , Unit step response and time domain specifications of first order, second order system. steady state error, error constants.	**10Hrs** **L1,L2**
Module 3 Block diagram algebra, Reduction of block diagram, Signal flow graphs, Gain formula for signal flow graphs, State diagram from differential equations.	**10Hrs** **L2,L3**
Module 4 **Stability of linear control systems:** Rouths criterion, Root locus, Determination of phase margin and gain margin using root locus.	**10 Hrs** **L2,L3**
Module 5 **Frequency domain analysis:** Stability analysis using Polar plot, Nyquist plot, Bode plot, Determination of phase margin and gain margin using Bode plot.	**10 Hrs.** **L2,L3**

Course Outcomes: The student on completion of the course will be able to:

CO1	Identify the type of control and control actions.
CO2	Develop the mathematical model of the physical systems.
CO3	Estimate the response and error in response of first and second order systems Courseed to standard input signals.
CO4	Represent the complex physical system using block diagram and signal flow graph and obtain transfer function.
CO5	Analyse a linear feedback control system for stability using Hurwitz criterion, Routh's criterion and root Locus technique in complex domain.
CO6	Analyse the stability of linear feedback control systems in frequency domain using polar plots, Nyquist and Bode plots.

Text Books:

1. Automatic Control Systems, Farid G., Kuo B. C., McGraw Hill Education, 10thEdition,2018
2. Modern control Engineering, K. Ogeta, Pearson, 5th Edition,2010.

Reference Books:

1. Control Systems Engineering, Norman S Nice, Fourth Edition, Wiley StudentEdition,2007.
2. Control systems, Manik D. N., Cengage,2017,

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SEMESTER - VII

HYDRAULIC CIRCUITS AND PROGRAMMABLE LOGIC CONTROLLERS (PLC)

Course Code	**18MA72**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module 1 **INTRODUCTION TO FLUID POWER:** Components, advantages and applications, Pascal's law and its applications, Fluids for hydraulic system: types, properties, and selection, Additives, effect of temperature and pressure on hydraulic fluid, Seals, sealing materials, compatibility of seal with fluids, Types of pipes, hoses, and quick acting couplings, Pressure drop in hoses/pipes, Fluid conditioning through filters, strainers, Sources of contamination and contamination control.	**10 Hours (L1, L2, L3)**
Module 2 **PUMPS AND ACTUATORS:** Classification of hydraulic pumps, Pumping theory Construction and working of gear, vane, piston, fixed and variable displacement pumps., Pump performance, Selection factors, Numerical problems on pumps, Classification of cylinders – single and double acting cylinder, Symbolic representation of hydraulic actuators, Mounting arrangements, cushioning, special types of cylinders, problems on cylinders, Classification of hydraulic motors, Construction and working of gear, vane, and piston motors, Theoretical torque, power, flow rate, and hydraulic motor performance.	**10 Hours (L1, L2, L3)**
Module 3 **CONTROL COMPONENTS AND CIRCUIT DESIGN OF HYDRAULIC SYSTEMS**: Classification of control valves, Directional Control Valves (DCV): symbolic representation, constructional features of poppet, sliding spool, rotary type valves, solenoid and pilot operated DCV, shuttle valve, and check valves, Pressure Control Valves (PCV): types, direct operated types and pilot operated types, Flow Control Valves: compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, Symbolic representation of DCV, PCV, and FCV. Hydraulic circuit design: Control of single-acting hydraulic cylinder, Control of double-acting hydraulic cylinder, Regenerative circuit, Pump unloading circuit, Counterbalance valve application, Metering-in, metering-out and bleed-off circuits	**10 Hours (L1, L2, L3)**
Module 4 **INTRODUCTION TO PNEUMATIC SYSTEMS:** Advantages and limitations, Applications, Choice of working medium, Characteristics of compressed air, Structure of pneumatic control system, Fluid conditioners - dryers and FRL unit, Pneumatic actuators: Linear cylinder – types, working, construction and applications, Rotary cylinders – types, working, construction and applications, End position cushioning, seals, and mounting arrangements, symbols, Use of memory valve, Quick exhaust valve, Time delay valve, Shuttle valve.	**10 Hours (L1, L2, L3)**
Module 5 **FUNDAMENTALS OF PROGRAMMABLE LOGIC CONTROLLER (PLC):** Definition, Advantages, Functions of PLC, Evolution of the modern PLC, Types of PLC, Block diagram of PLC, PLC timers and counters, Data handling, Communication in PLCs, Introduction to logic, ladder design, and switches, Data Acquisition (SCADA) System.	**10 Hours (L1, L2, L3, L4)**

Course Outcomes: After studying this course, students will be able to:

CO1	Explain fluid power systems.
CO2	Understand hydraulic pumps and motors.
CO3	Apply hydraulics concept to design hydraulic circuits using different valves.
CO4	Understand PLC and automation based on different applications.

Textbooks:

1. "Fluid Power with Applications", Anthony Esposito, Pearson Edition, 2000.
2. John Pippenger, Tyler Hicks, "Industrial Hydraulics", McGraw Hill International Edition, 1980.

3. "PLC and Industrial Automation", Madhuchhanda Gupta and Samarjit Sen Gupta, Penram International Pub. (Indian) Pvt. Ltd., 2011.

Reference books:

1. Majumdar S.R., "Oil Hydraulics", Tata McGraw Hill, 2002.
2. John W Webb, Ronald A Reis, "Programmable Logic Controllers: Principles and Application", PHI Learning, New Delhi, 5th Edition

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SEMESTER - VII

SURFACE ENGINEERING

Course Code	**18MA731**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBTLevel
Module - 1 **FRICTION:** Topography of Surfaces – Surface features – Properties and measurement – Surface interaction –Adhesive Theory of Sliding Friction – Rolling Friction – Friction properties of metallic and nonmetallic materials – Friction in extreme conditions – Thermal considerations in sliding contact.	**08 Hours** **L1, L2, L3**
Module -2 **WEAR:** Introduction – Abrasive wear, Erosive, Cavitation, Adhesion, Fatigue wear and Fretting Wear- Laws of wear – Theoretical wear models – Wear of metals and nonmetals – International standards in friction and wear measurements.	**08 Hours** **L1, L2, L3**
Module - 3 **CORROSION:** Introduction – Principle of corrosion – Classification of corrosion – Types of corrosion – Factors influencing corrosion – Testing of corrosion – In-service monitoring, Simulated service, Laboratory testing – Evaluation of corrosion – Prevention of Corrosion – Material selection, Alteration of environment, Design, Cathodic and Anodic Protection, Corrosion inhibitors.	**08 Hours** **L1, L2, L3**
Module - 4 **SURFACE TREATMENTS:** Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings.	**08 Hours** **L1, L2, L3**
Module - 5 **ENGINEERING MATERIALS:** Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology Nano Tribology.	**08 Hours** **1, L2, L3**

Course outcomes: After studying this course, students will be able to:

CO1	Understand the basic concept of friction, wear and corrosion of materials and their types
CO2	Understand the principle of different Surface treatments and coating techniques based on the applications
CO3	Apply the techniques Surface treatments and coating techniques
CO4	Differentiate the application of engineering materials based on the properties

Text Books:

1. Rabinowicz. E,"Frictionand Wear of materials",John Willey&Sons, UK,1995
2. G.W. Stachowiak & A.W .Batchelor , "Engineering Tribology", Butterworth-Heinemann, UK, 2005

Reference Book:

1. Halling, J. (Editor) – "Principles of Tribology ", Macmillian –1984.
2. Williams J.A. "Engineering Tribology", Oxford Univ. Press,1994.
3. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,"Fundamentals of Tribology", Prentice –Hall of India Pvt Ltd , New Delhi,2005
4. Fontana G., "Corrosion Engineering", McGraw Hill,1985

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SEMESTER - VII

QUALITY ASSURANCE

Course Code	**18MA732**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBTLevel
Module 1 **INTRODUCTION TO QUALITY:** Definition of Quality, Quality function, Dimensions of quality, Quality engineering terminology, Brief history of quality methodology, Statistical methods for quality improvement, Quality Costs – Four categories costs and hidden cost. Introduction to Quality Function Deployment. **QUALITY ASSURANCE:** Definition and concept of quality assurance, departmental assurance activities. Quality audit concept, audit approach etc.	**08Hours** **L1, L2,**
Module 2 **STATISTICAL PROCESS CONTROL** – Chance and Assignable causes of variation. Basic principles of control charts, choice of control limits, sample size and sampling frequency, rational subgroups. Analysis of patterns of control charts Frequency distribution and Histogram. **PROCESS CAPABILITY:** Basic definitions, standardized formula, relation to product tolerance and Six-Sigma concept of process capability.	**08 Hours** **L1,L2,L3,**
Module 3 **Control charts for X- bar and Range(R)**, Statistical basis of the charts, development and sue of X- bar and r charts, interpretation of charts Control charts for X-bar and standard deviation (S), development and use of X-bar and S Charts.	**08 Hours** **L1,L2,L3**
Module 4 **Control chart for fraction non – conforming (defectives) –** development of control chart, brief discussion on variable sample size. Control chart for non-conformities (defects) – development and operation of control chart for constant sample size and variable sample size. Choice between variables and attributes control charts.	**08 Hours** **L1,L2,L3**
Module 5 **OPERATING CHARACTERISTIC CURVES:** Construction and use. Acceptance plans – single, double and multiple sampling. Determinations of average outgoing quality, average outgoing quality level, average total inspection, production risk and consumer risk. **ISO QUALITY SYSTEM:** ISO/QS9000 Quality Systems – History of ISO9000 standards, QS9000 quality standards, goals and their standards.	**08 Hours** **L1,L2,L3,**

Course Outcomes: After studying this course, students will be able to:

CO1	Explains the basic concept of Quality, Control Charts and Acceptance Sampling
CO2	Construct control charts and evaluate revised control limits
CO3	Analyze process capability and operating characteristic curves

Text Books:

1. Douglas C Montgomery, Introduction to Statistical Quality Control, John Wiley, Seventh Edition, 2012.

Reference Book:

1. Grant E.L. and Leavenworth, Statistical Quality Control, TMH, 2000.
2. IS 2500 Standard sampling plan.

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SEMESTER - VII

JIGS AND FIXTURES

Course Code	**18MA733**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBTLevel
Module 1 **LOCATING AND CLAMPING PRINCIPLES:** Introduction, function and advantages of jigs and fixtures – basic elements – principles of location – locating methods and devices – redundant location – principles of clamping – types of clamp, mechanical actuation – pneumatic and hydraulic actuation standard parts – drill bushes and special types of bushes– tolerances and materials used**.**	**8 Hours** **L1, L2**
Module 2 **JIGS AND FIXTURES:** Elements of jig, Design consideration in jigs and fixtures, selection of materials, types of jigs – post, turnover, channel, latch, box, pot, angular post jigs – indexing jigs, jig feet and legs, chip control. Fixtures: general principles of milling, lathe, boring, broaching and grinding fixtures, inspection and welding fixtures.	**8 Hours** **L1,L2,L3**
Module 3 **PRESS WORKING TERMINOLOGIES AND ELEMENTS OF CUTTING DIES:** Press working terminologies, operations, types of presses, shearing action, clearances, press work materials, Principles of die design: screws and dowels, components of dies, die block, Punch and types of punch, punch support, punch shedders. Pilots, strippers, guiding stock, stops.	**8 Hours** **L1,L2,L3**
Module 4 **BENDING AND DRAWING DIES:** Introduction, Difference between bending and drawing, progressive die, compound die, combination die. Special methods of bending and drawing, types of bending dies, – spring back – knockouts – direct and indirect – pressure pads – ejectors – variables affecting metal flow in drawing operations – draw die inserts – draw beads- ironing, single and double action dies.	**8 Hours** **L1,L2,L3**
Module 5 **OTHER FORMING TECHNIQUES:** Bulging, swaging, embossing, coining, curling, hole flanging, shaving and sizing, assembly, recent trends in forming , computer aids for sheet metal forming analysis. Single minute exchange of dies: introduction, stages, implementation and effects, reducing set-up cost and time. Poka yoke: objective, system for mistake proofing, 5 whys, six mistake proofing techniques, some examples of poke-yoke.	**8 Hours** **L1,L2,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	Able to outline and define, classify of different clamp locating methods and devices, jigs, fixtures, press tools, dies and forming techniques.
CO2	Ability to describe the different types of metal forming process and its parameter with an example.
CO3	Adapt to make use of suitable variables of metal flow in forming technique and dies, principles of location and clamping, design and development of dies, jigs, fixtures and press tools.

Text books:

1. "Jigs and Fixtures", Joshi, P.H. Second Edition, Tata McGraw Hill Publishing Co., Ltd., New Delhi, 2004.
2. "Press tools – Design and Construction Joshi P.H", wheels publishing, 1996

Reference books:

1. "Design of Jigs Fixtures & Press Tools", Venkataraman. K., Tata McGraw Hill, New Delhi, 2005.
2. "Tool Design", Donaldson, Lecain and Goold 3rd Edition, Tata McGraw Hill, 2000.
3. "Jigs and Fixture Design", Hoffman Thomson Delmar Learning, Singapore, 2004.
4. ASTME Fundamentals of Tool Design Prentice Hall of India.
5. Design Data Hand Book, PSG College of Technology, Coimbatore

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SEMESTER - VII

FACILITY PLANNING AND DESIGN

Course Code	**18MA741**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	**Hours/RBTLevel**
Module 1 **PLANT LOCATION AND LAYOUT:** Factors influencing plant location, Theories of plant location and location economics. PLANT LAYOUT: Objectives of plant layout, Principles of plant layout, types of plant layout, their merits and demerits. **MATERIAL HANDLING:** Definition, principles, system design and selection of equipment, UNIT load concepts, basic layout types – immer, Nadler, Muther, Apple James and Ree's approaches to plant layout, Modular design concept, Production Line balancing.	**8 Hours L1, L2**
Module 2 **COMPUTER AIDED LAYOUT: CRAFT, COFAD, PLANET, CORELAP, ALDEP.** **CONSTRUCTION OF THE LAYOUT:** Methods of constructing the layout, evaluation of layout, efficiency indices, presenting layout to management, implementing layout.	**8Hours L1,L2,L3**
Module 3 **SPACE DETERMINATION AND AREA ALLOCATION:** Factors for consideration in space planning, receiving, storage, production, shipping, other auxiliary service actions, Establishing total space requirement, area allocation factors to be considered, expansion, flexibility, aisles column and area allocation procedure. Design of layout using Travel chart, plot plan, block plan, Sequence demand straight line method and non-directional method.	**8 Hours L1,L2,L3**
Module 4 **QUANTITATIVE APPROACHES TO FACILITIES PLANNING:** Deterministic models – Single and multi facility location models, Location allocation problems. **QUANTITATIVE APPROACHES TO FACILITIES PLANNING:** Quadratic assignment problem, Warehouse layout models, plant location problems. Conveyor models. Storage models.	**8 Hours L2,L3**
Module 5 **PROBABILISTIC MODELS:** Conveyor models, waiting line models and simulation models. Evaluation, selection, implementation and maintenance of the facilities plan.	**8 Hours L2,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	Explain objectives, principles, merits , demerits and efficiency of plant layout
CO2	Understand the design procedure, establishment of facilities and models and maintenance of plant layout
CO3	Analyze the plant location and space allocations for layout

Textbooks:

1. Facilities Planning -Thompkins. J A and White, J. A.
2. Facility layout and Location -Francies, R.L. and White, J.A.
3. Plant Layout and Material handling -James M Apple, 2nd Edition, John, Wiely and Sail.

Reference Books:

1. Practical plant layout -Muther Richard, - McGraw Hill-1955.
2. Facilities Design -Sunderesh Heragu, , PWS Publishing Company, ISBN- 0-534-95183.
3. Plant Layout Design -James M Moore., Mac Millon Co. 1962 LCCCN : 61-5204.

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SEMESTER – VII

PROCESS PLANNING

Course Code	**18MA742**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBTLevel
Module 1 **INTRODUCTION TO PROCESS PLANNING** Introduction- methods of process planning-Drawing interpretation-Material evaluation – steps in process selection. Production equipment and tooling selection.	**8 Hours** **L1, L2, L3**
Module 2 **PROCESS PLANNING ACTIVITIES** Process parameters calculation for various production processes-Selection jigs and fixtures election of quality assurance methods - Set of documents for process planning-Economics of process planning- case studies.	**8Hours** **L1,L2,L3**
Module 3 **INTRODUCTION TO COST ESTIMATION** Importance of costing and estimation –methods of costing-elements of cost estimation – Types of estimates – Estimating procedure- Estimation labor cost, material cost- allocation of over head charges- Calculation of depreciation cost.	**8 Hours** **L1,L2,L3**
Module 4 **PRODUCTION COST ESTIMATION** Estimation of Different Types of Jobs - Estimation of Forging Shop, Estimation of Welding Shop, Estimation of Foundry Shop.	**8 Hours** **L1,L2,L3**
Module 5 **MACHINING TIME CALCULATION** Estimation of Machining Time - Importance of Machine Time Calculation- Calculation of Machining Time for Different Lathe Operations ,Drilling and Boring - Machining Time Calculation for Milling, Shaping and Planning - Machining Time Calculation for Grinding.	**8 Hours L1,L2,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	Explain process planning, quality assurance and costing & estimation
CO2	Explain the location of jobs on machine tools
CO3	Select tools for operations on turning, milling and shaping operations
CO4	Estimate the cutting time and cost for turning, milling and shaping operations

Text Books:

1. "Process planning, Design/Manufacture Interface", Peter scalon, Elsevier science technology Books, Dec 2002.

Reference Books:

1. "Manufacturing Processes and systems", Ostwalal P.F. and Munez J., 9th Edition, John Wiley, 1998.
2. "Operations Management", Russell R.S and Tailor B.W, 4th Edition, PHI, 2003.
3. "Product Design and Manufacturing", Chitale A.V. and Gupta R.C., 2nd Edition, PHI, 2002.

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SEMESTER – VII

PRECISION ENGINEERING

Course Code	**18MA743**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 4

Content	Hours/RBT Level
Module 1 **CONCEPTS OF ACCURACY AND MACHINE TOOLS:** Part Accuracy – errors, accuracy of machine tools – spindle accuracy – displacement accuracy – errors due to numerical interpolation	**8 Hours** **L1, L2, L3**
Module 2 **STIFFNESS, THERMAL EFFECTS AND FINISH MACHINING:** Overall stiffness of Lathe – compliance of work piece – errors caused by cutting forces – deformation in turning – heat sources – thermal effects – Finish Turning, Surface roughness.	**8 Hours** **L1,L2,L3**
Module 3 **DIMENSIONING:** Definition of terms – Key dimension – Superfluous dimension – dimensional stepped shaft – assigning tolerances in the constituent dimensions – dimensional chains.	**8 Hours** **L1,L2,L3**
Module 4 **MICRO-MACHINING MICRO-FABRICATION:** Micro Machining – Photo resist process – Lithography – LIGA Process – Optical, processing of materials – micro forming, diamond turning – micro positioning devices – etching – physical vapour deposition – Chemical vapour deposition	**8 Hours** **L1,L2,L3**
Module 5 **SMART STRUCTURES AND MICRO ACTUATORS:** Smart structures and applications – smart sensors – micro valves – MEMS – Micro motors – Micro pumps – micro dynamometer– micro optics – micro nozzles.	**8 Hours** **L1,L2,L3,**

Course Outcomes: After studying this course, students will be able to:

CO1	Understand the technology and variables involved in precision engineering
CO2	Be able to select the type of microfabrication technique required for any specific product
CO3	Have the basic knowledge for selecting the type of dimensioning and machine tools for the fabrication process.
CO4	Know about the special microfabrication and gauging when their use is warranted.
CO5	Have a broad knowledge of micromachining and smart materials

Text Books:

1. "Precision Engineering in Manufacturing", Murthy R.L., New Age International Pvt, 2005.
2. "Micro sensors, MEMS and Smart Devices", Juliar W.Gardner. Vijay K. Varadan, John Wiley and sons, 2001.

Reference Book:

1. "The Science and Engineering of Microelectronic Fabrication", Stephen A. Campbell,Oxford University Press, 1996.
2. "Understanding Smart Sensors", Raady Frank, Artech. House, Boston, 1996.
3. MEMS Hand Book, CRC Press, 2001

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SEMESTER – VII

SUPPLY CHAIN MANAGEMENT

Course Code	**18MA751**	CIE Marks	40
Number of Lecture Hours/Week (L:T:P)	03	SEE Marks	60
Total Number of Lecture Hours	40	Exam Hours	03

No. of Credits: 3

Course Learning Objectives:

CLO1	To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.
CLO2	To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management & design problems.
CLO3	To study the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategicalliances.

Content	**No. of Hours/RBT levels**
MODULE 1 Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.	**8 Hours L1, L2, L3**
MODULE 2 Strategic Sourcing Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base- Supplier Development - World Wide Sourcing.	**8 Hours L1, L2, L3**
MODULE 3 Warehouse Management Stores management-stores systems and procedures- incoming materials control-stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling-transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement. Supply Chain Network Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models.	**8 Hours** **L1, L2, L3, L4**
MODULE 4 Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.	**8 Hours L2, L3, L4**
MODULE 5 Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Future of IT in supply chain- E- Business in supply chain.	**8 Hours** **L1, L2, L3, L4**

Course Outcomes: After learning the course, the students should be able to:

CO1	Understand the framework and scope of supply chain management.
CO2	Build and manage a competitive supply chain using strategies, models, techniques and Information technology.

CO3	Plan the demand, inventory and supply and optimize supply chain network.
CO4	Understand the emerging trends and impact of IT on Supply chain.

TEXT BOOKS:

1. Janat Shah, Supply Chain Management – Text and Cases, Pearson Education, 2009.
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHILearning / Pearson Education, 2007.

REFERENCES:

1. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education, 5 th Edition,2007.
2. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill,2005.
3. Altekar Rahul V, Supply Chain Management-Concept and Cases, PHI,2005.
4. Shapiro Jeremy F, Modeling the Supply Chain, Thomson Learning, Second Reprint ,2002.
5. Joel D. Wisner, G. Keong Leong, Keah-Choon Tan, Principles of Supply Chain Management- A Balanced Approach, South-Western, Cengage Learning2008.

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SEMESTER – VII

Optimization Techniques

Course Code	**18MA752**	CIE Marks	40
Number of Hours/Week (L:T:P)	3L	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Contents	**Hours/ RBT Levels**
Module –I: Introduction: Statement of optimization problem, Design vector, Design constraints, Objective function, Classification of optimization problems based on :constraints, nature of design variables, nature of the equations involved **Single variable optimization:** Necessary and sufficient conditions, Multivariable optimization with no constraints: Necessary and sufficient conditions, Semi definite case, Saddle point, Multivariable optimization with equality constraints, Solution by direct substitution, Lagrange Multipliers, Interpretation of Lagrange multipliers, Multivariable optimization with inequality constraints: Khun Tucker conditions(concept only)	**10 Hours L2, L3, L4**
Module II: Nonlinear Programming: One-Dimensional Minimization Methods Introduction, Unimodal Function, Elimination methods: unrestricted search, fixed step size, accelerated step size, Exhaustive search: dichotomous search, interval halving method, Fibonacci method, golden section method, Interpolation methods: Quadratic and cubic interpolation method, direct root method, Newton method, Quasi-Newton method, secant method	**12 Hours L2, L3, L4**
Module III: Nonlinear Programming: Direct search methods: Classification of unconstrained minimization methods, rate of convergence, scaling of design variables, random search methods , univariate method, pattern directions, Powell's method, Simplex method.	**06 Hours L2,L3**
Module IV: Nonlinear Programming: Indirect Search (Descent) Methods: Gradient of a function, Steepest decent method, Fletcher Reeves method, Newtons method, Davidon-Fletcher-Powell method.	**06 Hours L2,L3**
Module V: Integer Programming: Introduction, Graphical representation, Gomory's cutting plane method: concept of a cutting plane, Gomory's method for all-integer programming problems, Balas' algorithm for zero–one programming, Branch-and- Bound Method.	**06 Hours L2,L3**

Course Outcomes: After studying this course, students will be able to:

CO1	Define and use optimization terminology, concepts, and understand how to classify an optimization problem.
CO2	Understand how to classify an optimization problem.
CO3	Apply the mathematical concepts formulate the problem of the systems.
CO4	Analyse the problems for optimal solution using the algorithms.
CO5	Interpret the optimum solution.

Text Books:

1. S. S. Rao, Engineering Optimization Theory and Practice, Fourth Edition, John Wiley & Sons, 2009.

Reference Books:

1. A. D. Belegundu, T.R. Chanrupatla, Optimisation Concepts and Applications in Engineering, Cambrige UniversityPress,2011
2. Ravindran, K. M. Ragsdell, and G. V. Reklaitis, Engineering Optimization: Methods and Applications, 2nd ed., Wiley, New York,2006.

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SEMESTER – VII

MODELING AND SIMULATION LABORATORY

Course Code	**18MAL76**	CIE Marks	40
Hours/Week	0:2:2	SEE Marks	60
Total Hours	40	Exam Hours	03

No of Credits: 2

Content	**Hours/RBT Level**
PART-A 1. Analysis of stepped bars and trusses (4 problems) 2. Analysis of stress concentration in machine component (L –bracket) and plate with hole (2 Problems) 3. Analysis of cantilever and simply supported beams carrying point and UDL (2 Problems) 4. Modalanalysis of beams and rectangular plate (2 Problems) **5.** Thermal analysis of 2D component Courseing to heat transfer through convection and conduction (2 Problems)	**20 Hours** **L1, L2, L3, L4**
PART-B 1. Introduction to MAT LAB Commands 2. Program for calculation of Invariants, principal stresses and directions from stress tensor 3. MAT LAB Script for mohr' circle construction of from stress tensor 4. Modelling and simulation of spring-mass-damper system through MATLAB.	**20 Hours** **L1, L2, L3, L4**

Course Outcomes: At the end of course students able to

C01	Understand basic principles of finite element modelling and solutions
C02	Model and Analyze mechanical components for stress and deformation with the help of FEA tools
C03	Develop program for numerical calculation and simulation of mechanical models

Suggested Packages:
ANSYS, NASTRAN, MAT LAB

Scheme for Examination:

One Question from Part A	40 Marks
One Question from Part B	40 Marks
Viva-Voce	20 Marks
Total	**100 Marks**

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SEMESTER – VII

HYDRAULIC CIRCUITS AND PROGRAMMABLE LOGIC CONTROLLERS (PLC) LABORATORY

Course Code	**18MAL77**	CIE Marks	40
Hours / Week	1:0:2	SEE Marks	60
Total Hours	40	Exam Hours	03

No. Of Credits:2

Content	**Hours/RBT Level**
Part A 1. Meter-in and Meter-out in designing of Hydraulic Circuits using Single-rod cylinder & 4/2 DCV/Manual lever operated valve. 2. Application of 4/3 position tandem centre configuration, DCV/Manually operated Valve to demonstrate application in forklifts. 3. Operation of Hydraulic motor using 4/3-way valve. 4. Application of Hydraulic accumulator as stand by hydraulic energy source during power failures. 5. Design a hydraulic circuit and verify its operation over a hydraulic press.	**16 Hours (L2, L3)**
Part B **LOGIC GATES** 1. To draw the ladder program for various logic gates using STEP 7 software and to verify the correctness of the same using the PLC. **DEMORGAN LAW** 2. To draw the ladder diagrams for De Morgan's laws and to verify the truth tables of the same using the PLC. **ARITHMETIC OPERATIONS** 3. To draw and verify the ladder diagram for arithmetic operations using the PLC. **TWO MOTOR SYSTEM (USE OF OFF DELAY TIMER)** 4. To draw and verify the ladder diagram for the given problem using the PLC. **TWO MOTOR SYSTEM (USE OF ON DELAY TIMER)** 5. To draw and verify the ladder diagram for the given problem using the PLC. **SELECTION COMMITTEE** 6. To draw and verify the ladder diagram for the given problem using the PLC. RAILWAY PLATFORM SIGNALLING 7. To draw and verify the ladder diagram for the given problem using the PLC.	**24 Hours (L2, L3)**

Course Outcomes: On completion of the course, students will be able to:

CO1	Understand the working of hydraulic valves, hydraulic motors, hydraulic packs and PLC circuits.
CO2	Design and verify the hydraulic circuits.
CO3	Analyze PLC circuit diagrams by using basic electronic circuits.

Books:

1. "Fluid Power with applications", Anthony Esposito, Pearson edition, 2000.
2. "PLC and Industrial application", Madhuchhandan Gupta and SamarjitSen Gupta, Penram International Pub. (Indian) Pvt. Ltd., 2011.
3. 2. FESTO, Fundamentals of Pneumatics, Vol I, II and III.

Scheme of examination:

One Question from Part A	=	40 Marks (10 marks for write up + 30 for conduction)
One Question from Part B	=	40 Marks (10 marks for write up + 30 for conduction)
Viva-voce	=	20 Marks

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SEMESTER – VIII

TOTAL QUALITY MANAGEMENT

Course Code	**18MA81**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBTLevel
Module1 **Principles and Practice:** Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.	**08Hours** **L1,L2,L3,L4**
Module2 **Leadership:** Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making.	**08 Hours** **L1,L2,L3,L4**
Module 3 **Customer Satisfaction and Customer Involvement:** Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies. Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.	**08 Hours** **L1,L2,L3,L4**
Module 4 **Continuous Process Improvement:** process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies. Statistical Process Control : Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.	**08 Hours** **L1,L2,L3,L4**
Module 5 **Tools and Techniques:** Benching marking, information technology, quality management systems, environmental management system, and quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance.	**08 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Explain the various approaches of TQM.
CO2	Infer the customer perception of quality
CO3	Analyze customer needs and perceptions to design feedback systems.
CO4	Apply statistical tools for continuous improvement of systems
CO5	Apply the tools and technique for effective implementation of TQM.

Text Books:

1. Total Quality Management: Dale H. Besterfield, Publisher -Pearson Education India, ISBN: 8129702606, Edition 03.
2. Total Quality Management for Engineers: M. Zairi, ISBN:1855730243, Publisher: Wood head Publishing

Reference Books:

1. Managing for Quality and Performance Excellence by James R. Evans and William M Lindsay, 9th edition, Publisher Cengage Learning.
2. A New American TQM, four revolutions in management, Shoji Shiba, Alan Graham, David Walden,

Productivity press, Oregon, 1990
3. Organizational Excellence through TQM, H. Lal, New age Publications, 2008.
4. Engineering Optimization Methods and Applications, A Ravindran, K, M. Ragsdell, Willey India Private Limited,2nd Edition,2006.
5. Introduction to Operations Research- Concepts and Cases, F.S. Hillier. G.J. Lieberman, 9th Edition, Tata McGraw Hill. 2010.

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SEMESTER – VIII

FLEXIBLE MANUFACTURING SYSTEMS

Course Code	**18MA821**	CIE Marks	20
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	80
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module1 **PLANNING, SCHEDULING AND CONTROL OF FLEXIBLE MANUFACTURING SYSTEMS:** Introduction to FMS– development of manufacturing systems – benefits – major elements – types of flexibility – FMS application and flexibility –single product, single batch, n – batch scheduling	**8 Hours** **L1, L2, L3**
Module 2 **COMPUTER CONTROL AND SOFTWARE FOR FLEXIBLE MANUFACTURING SYSTEMS:** Introduction – composition of FMS– hierarchy of computer control –computer control of work center and assembly lines – FMS supervisory computer control	**8 Hours** **L1,L2,L3,L4**
Module 3 **FMS SIMULATION AND DATA BASE:** Application of simulation – model of FMS– simulation software – limitation – manufacturing data systems – data flow – FMS database systems – planning for FMS database	**8 Hours** **L1,L2,L3,L4**
Module 4 **GROUP TECHNOLOGY AND JUSTIFICATION OF FMS** Introduction – matrix formulation – mathematical programming formulation –graph formulation – knowledge based system for group technology – economic justification of FMS	**8 Hours** **L1,L2,L3,L4**
Module 5 **APPLICATIONS OF FMS AND FACTORY OF THE FUTURE FMS**: Application in machining, sheet metal fabrication, prismatic component production – aerospace application – FMS development towards factories of the future – artificial intelligence and expert systems in FMS	**8 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Explain the concepts of Planning, Scheduling and control of Flexible Manufacturing systems
CO2	Perform Planning, Scheduling and control of Flexible Manufacturing systems
CO3	Apply flexible manufacturing system to perform simulation on software's use of group technology to product classification
CO4	Apply the concept of artificial intelligence and expert systems in FMS

TEXT BOOKS

1. Jha, N.K. "Handbook of flexible manufacturing systems", Academic Press Inc., 1991.

REFERENCES:

1. Radhakrishnan P. and Subramanyan S., "CAD/CAM/CIM", Wiley Eastern Ltd., New AgeInternational Ltd., 1994.
2. Raouf, A. and Ben-Daya, M., Editors, "Flexible manufacturing systems: recent development", Elsevier Science, 1995.
3. Groover M.P., "Automation, Production Systems and Computer Integrated Manufacturing", Prentice Hall of India Pvt., New Delhi, 1996.
4. Kalpakjian, "Manufacturing Engineering and Technology", Addison-Wesley Publishing Co., 1995.
5. Taiichi Ohno, "Toyota Production System: Beyond large-scale Production", Productivity Press (India) Pvt. Ltd. 1992

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SEMESTER – VIII

PRODUCT LIFECYCLE MANAGEMENT

Course Code	**18MA822**	CIE Marks	20
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	80
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBT Level
Module - 1 **INTRODUCTION TO PLM AND PDM:** Introduction to PLM, Need forPLM, Opportunities and benefits of PLM, different views of PLM, components of PLM, phases of PLM, PLM feasibility study. PLM Strategies, strategy elements, its identification, selection and implementation. Product Data Management, implementation of PDM systems.	**8 Hours** **L1, L2, L3**
Module – 2 **PRODUCT DESIGN:** Engineering design, organization and decomposition in product design, product design process, methodical evolution in product design, concurrent engineering, design for 'X' and design central development model. Strategies for recovery at end of life, recycling, human factors in product design. Modeling and simulation in product.	**8 Hours** **L1,L2,L3,L4**
Module – 3 **PRODUCT DEVELOPMENT:** New Product Development, Structuring new product development, building decision support system, Estimating market opportunities for new product, new product financial control, implementing new product development, market entry decision, launching and tracking new product program. Concept of redesign of product.	**8 Hours** **L1,L2,L3,L4**
Module – 4 **TECHNOLOGY FORECASTING:** Technological change, methods of technology forecasting, relevance trees, morphological methods, flow diagram and combining forecast of technologies Integration of technological product innovation and product development in business processes within enterprises, methods and tools in the innovation process according to the situation, methods and tools in the innovation process according to the situation.	**8 Hours** **L1,L2,L3,L4**
Module – 5 **PRODUCT BUILDING AND STRUCTURES:** Virtual product development tools for components, machines, and manufacturing plants: 3D CAD systems, digital mock-up, model building, model analysis, production (process) planning, and product data technology, Product structures: Variant management, product configuration, material master data, product description data, Data models, Life cycles of individual items, status of items.	**8 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Explain the various strategies of PLM and Product Data Management.
CO2	Describe decomposition of product design and model simulation.
CO3	Apply the concept of New Product Development and its structuring.
CO4	Analyze the technological forecasting and the tools in the innovation.
CO5	Apply the virtual product development and model analysis.

Text Books:

1. Product Lifecycle Management: Paradigm for 21st Century Product Realization, Stark, John. Springer-Verlag, 2004. ISBN 1852338105
6. Fabio Giudice, Guido La Rosa, Product Design for the environment-A life cycle approach, Taylor &

Francis 2006

Reference Books:

1. Saaksvuori Antti/ Immonen Anselmie, Product Life Cycle Management Springer, Dreamtech, 3-540-25731-4
2. Product Lifecycle Management, Michael Grieves, Tata McGraw Hill

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SEMESTER - VIII

PROJECT MANAGEMENT

Course Code	**18MA823**	CIE Marks	40
Number of Hours/Week (L:T:P)	3:0:0	SEE Marks	60
Total Number of Hours	40	Exam. Hours	03

Number of Credits: 3

Content	Hours/RBTLevel
Module 1 **Introduction:** Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles Project Selection and Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.	**08 Hours** **L1,L2,L3,L4**
Module 2 **Planning Projects:** Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organization, coding the WBS for the information system. Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart.	**08 Hours** **L1,L2,L3,L4**
Module 3 **Resourcing Projects:** Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control. Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kick off project, baseline and communicate project management plan, using Microsoft Project for project baselines.	**08 Hour** **L1,L2,L3,L4**
Module 4 **Performing Projects:** Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management. 28 Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.	**08 Hours** **L1,L2,L3,L4**
Module 5 **Network Analysis Introduction, network construction -** rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERTfor finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	**08 Hours** **L1,L2,L3,L4**

Course Outcomes: After studying this course, students will be able to:

CO1	Understand the selection, prioritization and initiation of individual projects and strategic role of project management.
CO2	Understand the work breakdown structure by integrating it with organization.
CO3	Understand the scheduling and uncertainty in projects.
CO4	Students will be able to understand risk management planning using project quality tools.
CO5	Understand the activities like purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.

CO6	Determine project progress and results through balanced scorecard approach
CO7	Draw the network diagram to calculate the duration of the project and reduce it using crashing.

Text Books:

1. Project Management, Timothy J Kloppenborg, Cengage Learning, Edition 2009.
2. Project Management, A systems approach to planning scheduling and controlling by Harold kerzner, CBS publication.
3. Project Management by S Choudhury, Mc Graw Hill Education (India) Pvt. Ltd. New Delhi, 2016

Reference Book:

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