SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)
(Affiliated to JNTUK, Kakinada), (Recognized by AICTE, New Delhi)
Accredited by NAAC with 'A' Grade
CHINNA AMIRAM (P.O):: BHIMAVARAM :: W.G.Dt., A.P., INDIA :: PIN: 534 204
Estd:1980

**SCHEME OF INSTRUCTION & EXAMINATION**
(Regulation R19)
**M.TECH (CAD/CAM)**
**DEPARTMENT OF MECHANICAL ENGINEERING**
**(**With effect from **2019-2020**Admitted Batch onwards**)**
**I-SEMESTER**

| Subject Code | Name of the Subject | Category | Cr. | L | T | P | Internal Marks | External Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| M19CAD 1101 | Geometric Modeling | PC | 3 | 3 | 0 | 0 | 25 | 75 | 100 |
| M19CAD 1102 | Computer Aided Manufacturing | PC | 3 | 3 | 0 | 0 | 25 | 75 | 100 |
| #PE-I | Program Elective-I | PE | 3 | 3 | 0 | 0 | 25 | 75 | 100 |
| #PE-II | Program Elective-II | PE | 3 | 3 | 0 | 0 | 25 | 75 | 100 |
| M19CAD 1109 | Advanced CAD Lab | PC | 2 | 0 | 0 | 4 | 25 | 75 | 100 |
| M19CAD 1110 | Advanced Manufacturing Lab | PC | 2 | 0 | 0 | 4 | 25 | 75 | 100 |
| M19 RD 1101 | Research Methodology and IPR | RD | 2 | 2 | 0 | 0 | 25 | 75 | 100 |
| M19 AC 1109 | Writing Skills for Scientific Communication | AC | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| | | **Total** | **18** | **16** | **0** | **8** | **175** | **525** | **700** |

| | Course Code | Course |
|---|---|---|
| #PE-I | M19CAD 1103 | Computational Methods in Engineering |
| | M19CAD 1104 | Material Technology |
| | M19CAD 1105 | Mechanical Vibrations |
| #PE-II | M19CAD 1106 | Mechatronics |
| | M19CAD 1107 | Industrial Robotics |
| | M19CAD 1108 | Modelling and Simulation of Manufacturing Systems |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1101** | **PC** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

## GEOMETRIC MODELING

**Course Objectives:**

| | |
|---|---|
| 1. | To highlight the importance of geometric modelling in design |
| 2. | To highlight the importance of geometric modelling in manufacturing. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Develop mathematical models to represent cubic curvesused for engineering applications. | K3 |
| 2. | Develop mathematical models to represent Bezier curvesused for engineering applications. | K3 |
| 3. | Select appropriate synthetic curves in modelling process | K3 |
| 4. | Develop mathematical models to represent surfaces used for engineering applications. | K3 |
| 5. | Model engineering components using solid modelling techniques. | K3 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Cubic splines –I Definition, Explicit and implicit equations, parametric equations, Algebraic and geometric form of cubic spline, Hermite cubic spline, tangent vectors, parametric space of a curve, blending functions. |
| **UNIT-II (10 Hrs)** | Four point form, reparametrization, truncating and subdividing of curves. Graphic construction and interpretation, composite pc curves. Bezier Curves: Bernstein basis, equations of Bezier curves, properties, derivatives. |
| **UNIT-III (8 Hrs)** | B-Spline Curves: B-Spline basis, equations, knot vectors, properties, and derivatives. |
| **UNIT-IV (10 Hrs)** | Surfaces: Bicubic surfaces, Coon's surfaces, Bezier surfaces, B-Spline surfaces, surfaces of revolutions, Sweep surfaces, ruled surfaces, tabulated cylinder, bilinear surfaces, Gaussian curvature |
| **UNIT-V (10 Hrs)** | Solids: Tricubic solid, Algebraic and geometric form. Solid modeling concepts: Wire frames, Boundary representation, Half space modeling, spatial cell, cell decomposition, classification problem. |

**Text Books:**

| | |
|---|---|
| 1. | Elements of Computer Graphics by Roger & Adams Tata McGraw Hill. |
| 2. | Geometric Modeling by Micheal E. Mortenson, McGraw Hill Publishers. |

**Reference Book:**

| | |
|---|---|
| 1. | Computer Aided Design and Manufacturing, K.Lalit Narayan, K.Mallikarjuna Rao, MMM Sarcar, PHI Publishers. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19CAD1102 | PC | 3 | 0 | 0 | 3 | 25 | 75 | 3 Hrs. |

## COMPUTER AIDED MANUFACTURING

**Course Objectives:**

| | |
|---|---|
| 1. | Familiarize numerical control (NC), computer numerical control (CNC), direct numerical control (DNC) machines, manual part programming, computer aided part programming and Microcontrollers. |
| 2. | Impart knowledge on group technology, cellular manufacturing, production planning & control and computer aided quality control. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understand the principles of NC, CNC and DNC technology and develop manual and computer aided part programming for turning and milling operations. | K2 |
| 2. | Explain the concept of tooling for CNC machines. | K2 |
| 3. | Apply the use of various transducers, Micro controllers, encoders and feedback devices in CAM. | K3 |
| 4. | Explain the concepts of group technology and cellular manufacturing. | K2 |
| 5. | Understand the concepts of production planning & control and computer aided quality control. | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **COMPUTER AIDED PROGRAMMING:** General information, APT programming, and Examples Apt programming problems (2D machining only). NC programming on CAD/CAM systems, the design and implementation of post processors .Introduction to CAD/CAM software, Automatic Tool Path generation. |
| **UNIT-II (10 Hrs)** | **TOOLING FOR CNC MACHINES:** Interchangeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. DNC Systems and Adaptive Control: Introduction, type of DNC systems, advantages arid disadvantages of DNC, adaptive control with optimization, Adaptive control with constrains, Adaptive control of machining processes like turning, grinding. |
| **UNIT-III (10 Hrs)** | **POST PROCESSORS FOR CNC:** Introduction to Post Processors: The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP — based- Post Processor: Communication channels and major variables in the DAPP — based Post Processor, th creation of a DAPP — Based Post Processor. |
| **UNIT-IV (8 Hrs)** | **MICRO CONTROLLERS:** Introduction, Hardware components, I/O pins, ports, external memory:, counters, timers and serial data I/O interrupts. Selection of Micro Controllers Embedded Controllers, Applications and Programming of Micro Controllers. Programmable Logic Controllers (PLC' s): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines. |

| | |
|---|---|
| **UNIT-V (10 Hrs)** | **COMPUTER AIDED PROCESS PLANNING:** Hybrid CAAP System, Computer Aided Inspection and quality control, Coordinate Measuring Machine, Limitations of CMM, Computer Aided Testing, Optical Inspection Methods, Artificial Intelligence and expert system: Artificial Neural Networks, Artificial Intelligence in CAD, Experts systems and its structures. |
| | |
| **Text Books:** | |
| 1. | Computer Control of Manufacturing Systems / Yoram Koren / Mc Graw Hill. 1983. |
| 2. | CAD/CAM Principles and Applications, P.N.Rao, TMH |
| | |
| **Reference Books:** | |
| 1. | Computer Aided Design Manufacturing – K. Lalit Narayan, K. Mallikarjuna Rao and M.M.M. Sarcar, PHI, 2008. |
| 2. | CAD / CAM Theory and Practice,/ Ibrahim Zeid,TMH |
| 3. | CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age |
| 4. | Principles of Computer Aided Design and Manufacturing, Farid Amirouche, Pearson |
| 5. | Computer Numerical Control Concepts and programming, Warren S Seames, Thomson. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19CAD1103 | PE | 3 | 0 | 0 | 3 | 25 | 75 | 3 Hrs. |

## COMPUTATIONAL METHODS IN ENGINEERING

**(Program Elective-I)**

**Course Objectives:**

| | |
|---|---|
| 1. | To know how to solve system of equations, ordinary differential equations and partial differential equations numerically. |
| 2. | To understand correlation and regression. |
| 3. | Approximating data using mathematical functions. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Find the solutions of system of linear and non linear equations. | K3 |
| 2. | Solve boundary value problems and characteristic value problems. | K3 |
| 3. | Understand various transformation techniques. | K2 |
| 4. | Understand Laplace and poisons equations. | K2 |
| 5. | Solve ordinary and partial differential equations numerically. | K3 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Introduction to numerical methods applied to engineering problems: Examples, solving sets of equations – Matrix notation – Determinants and inversion – Iterative methods – Relaxation methods – System of non-linear equations. Least square approximation fitting of non-linear curves by least squares –regression analysis- multiple linear regression, non linear regression - computer programs. |
| **UNIT-II (10 Hrs)** | Boundary value problems and characteristic value problems: Shooting method – Solution through a set of equations – Derivative boundary conditions – Rayleigh – Ritz method – Characteristic value problems. |
| **UNIT-III (10 Hrs)** | Transformation Techniques: Continuous fourier series, frequency and time domains, laplace transform, fourier integral and transform, discrete fourier transform (DFT), Fast fourier transform (FFT). |
| **UNIT-IV (10 Hrs)** | Numerical solutions of partial differential equations: Laplace's equations – Representations as a difference equation – Iterative methods for Laplace's equations – poisson equation – Examples – Derivative boundary conditions – Irregular and non – rectangular grids – Matrix patterns, sparseness – ADI method – Finite element method. |
| **UNIT-V (8 Hrs)** | Partial differential equations: Explicit method – Crank-Nickelson method – Derivative boundary condition – Stability and convergence criteria. Solving wave equation by finite differences-stability of numerical method –method of characteristics-wave equation in two space dimensions-computer programs. |

| | |
|---|---|
| **Text Books:** | |
| 1. | Steven C.Chapra, Raymond P.Canale ―Numerical Methods for Engineers, Tata Mc-Graw Hill. |
| 2. | Curtis F.Gerald, Partick.O.Wheatly,‖Applied numerical analysis, Addison-Wesley,1989. |
| 3. | .Douglas J.Faires, Riched Burden, Numerical methods, Brooks/Cole publishing company, 1998, Second edition. |
| | |
| **Reference Books:** | |
| 1. | Ward Cheney and David Kincaid ―Numerical mathematics and computing‖ Brooks/Cole publishing company, 1999, Fourth edition. |
| 2. | Riley K.F, M.P.Hobson and Bence S.J., Mathematical methods for physics and engineering, Cambridge University press,1999. |
| 3. | Kreysis, Advanced Mathematics. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1104** | **PE** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

## MATERIALS TECHNOLOGY

**(Program Elective-I)**

**Course Objectives:**

| | |
|---|---|
| 1. | To understand the relationship between the structure, properties, processing, testing and applications of strengthening mechanism, modern metallic, smart, non-metallic, advanced structural ceramic and composite materials. |
| 2. | To identify and select suitable materials for various engineering applications. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Gain knowledge on elastic & plastic deformation and strengthening mechanism of engineering materials. | K2 |
| 2. | Learn the structure, properties and applications of modern metallic materials, smart materials non-metallic materials and advanced structural ceramics. | K2 |
| 3. | Understand the fatigue and fracture failure mechanism of engineering materials. | K2 |
| 4. | Understand the mechanical behaviour of modern metallic materials. | K2 |
| 5. | Understand the mechanical behaviour of non metallic materials. | K2 |

## SYLLABUS

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Elasticity in metals, mechanism of plastic deformation, slip and twinning, role of dislocations, yield stress, shear strength of perfect and real crystals, strengthening mechanism, work hardening, solid solution, grain boundary strengthening. Poly phase mixture, precipitation, particle, fiber and dispersion strengthening, effect of temperature, strain and strain rate on plastic behavior, super plasticity, Yield criteria: Von-mises and Tresca criteria. |
| **UNIT-II (10 Hrs)** | Griffth's Theory, stress intensity factor and fracture Toughness, Toughening Mechanisms, Ductile and Brittle transition in steel, High Temperature Fracture, Creep, Larson – Miller parameter, Deformation and Fracture mechanism maps. |
| **UNIT-III (10 Hrs)** | Fatigue, fatigue limit, features of fatigue fracture,Low and High cycle fatigue test, Crack Initiation and Propagation mechanism and paris Law, Effect of surface and metallurgical parameters on Fatigue, Fracture of non-metallic materials, fatigue analysis, Sources of failure, procedure of failure analysis. Motivation for selection, cost basis and service requirements, Selection for Mechanical Properties, Strength, Toughness, Fatigue and Creep. |
| **UNIT-IV (10 Hrs)** | MODERN METALLIC MATERIALS: Dual Steels, Micro alloyed, High Strength Low alloy (HSLA) Steel, Transformation induced plasticity (TRIP) Steel, Maraging Steel, Inter metallics, Ni and Ti Aluminides. Processing and applications of Smart Materials, Shape Memory alloys, Metallic Glass Quasi Crystal and Nano Crystalline Materials. |

| | |
|---|---|
| **UNIT-V (8 Hrs)** | NONMETALLIC MATERIALS: Polymeric materials and their molecular structures, Production Techniques for Fibers, Foams, Adhesives and Coatings, structure, Properties and Applications of Engineering Polymers, Advanced Structural Ceramics WC, TiC, TaC, $A1_2O_3$, SiC, $Si_3N_4$, CBN and Diamond – properties, Processing and applications. |
| | |

| **Text Books:** | |
|---|---|
| 1. | Mechanical Behavior of Materials/Thomas H. Courtney/ McGraw Hill/2 ndEdition/2000 |
| 2. | Mechanical Metallurgy/George E. Dicter/McGraw Hill, 1998. |
| | |

| **Reference Books:** | |
|---|---|
| 1. | Selection and use of Engineering Materials 3e/Charles J.A/Butterworth Heiremann. |
| 2. | Engineering Materials Technology/James A Jacob Thomas F Kilduff/Pearson |
| 3. | Material Science and Engineering/William D Callister/John Wiley and Sons |
| 4. | Plasticity and plastic deformation by Aritzur. |
| 5. | Introduction to Ceramics, 2nd Edition by W. David Kingery, H. K. Bowen, Donald R. Uhlmann |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19CAD1105 | PE | 3 | 0 | 0 | 3 | 25 | 75 | 3 Hrs. |

**MECHANICAL VIBRATIONS**

**(Program Elective-I)**

**Course Objectives:**

| | |
|---|---|
| 1. | To gain the knowledge of mathematical modeling of a physical system and applying the principles of Newton's Second Law and conservation of energy to derive the equations of motion. |
| 2. | To study the response of a vibrating system with periodic excitation and understand the principle of vibration isolation. |
| 3. | To develop the equations of motion for a continuous system in elongation, bending and torsion to find the natural frequencies and mode shapes. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Determine the natural frequencies of single and two degrees of freedom systems without and with damping. | K3 |
| 2. | Develop a mathematical model for response to non periodic excitations | K3 |
| 3. | Determine the natural frequencies of multi degrees of freedom systems | K3 |
| 4. | Apply numerical methods to determine the natural frequencies and mode shapes. | K3 |
| 5. | Determine the natural frequencies and mode shapes of bars in elongation and torsion and beams in bending. | K3 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Single degree of Freedom systems: Undamped and damped free vibrations: forced vibrations ; coulomb damping; Response to harmonic excitation; rotating unbalance and support excitation, Vibration isolation and transmissibility, Vibrometers, velocity meters & accelerometers. |
| **UNIT-II (10 Hrs)** | Response to Non Periodic Excitations: unit Impulse, unit step and unit Ramp functions; response to arbitrary excitations, The Convolution Integral; shock spectrum; System response by the Laplace Transformation method. |
| **UNIT-III (10 Hrs)** | Multi degree freedom systems: Principal modes – undamped and damped free and forced vibrations; undamped vibration absorbers, Matrix formulation, stiffness and flexibility influence coefficients; Eigen value problem; normal modes and their properties; Free and forced vibration by Modal analysis; Method of matrix inversion; Torsional vibrations of multi – rotor systems and geared systems; Discrete-Time systems. |
| **UNIT-IV (8 Hrs)** | Numerical Methods: Rayliegh's, Stodola's, Matrix iteration, Rayleigh-Ritz Method and Holzer's methods |
| **UNIT-V (10 Hrs)** | Application of concepts: Free vibration of strings – longitudinal oscillations of bars-transverse vibrations of beams- Torsional vibrations of shafts. Critical speeds without and with damping, secondary critical speed. |

| | |
|---|---|
| **Text Books:** | |
| 1. | Elements of Vibration Analysis by Meirovitch. |
| 2. | Mechanical Vibrations by G.K. Groover. |
| | |
| **Reference Books:** | |
| 1. | Vibrations by W.T. Thomson |
| 2. | Mechanical Vibrations – Schaum series. |
| 3. | Vibration problems in Engineering by S.P. Timoshenko. |
| 4. | Mechanical Viabrations – V.Ram Murthy. |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1106** | **PC** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

## MECHATRONICS

## (Program Elective-II)

**Course Objectives:**

| | |
|---|---|
| 1. | To provide knowledge on electrical circuits, electronic components, sensors and signal conditioning. |
| 2. | To make familiar about control system and power electronics in designing mechatronics system |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Identification of key elements of mechatronics system and Outline appropriate sensors and actuators for an engineering application. | K2 |
| 2. | Describe various solid state electronic devices. | K2 |
| 3. | Understand the concepts of Hydraulic and pneumatic actuating systems. | K2 |
| 4. | Understand the concepts of digital electronics, micro processors, micro controllers and PLCs. | K2 |
| 5. | Understand the concept of signal processing and use of interfacing systems such as ADC and DAC | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors. |
| **UNIT-II (10 Hrs)** | Solid state electronic devices, PN junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications. |
| **UNIT-III (10 Hrs)** | Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems: Mechanical actuating systems and electrical actuating systems. |
| **UNIT-IV (10 Hrs)** | Digital electronics and systems, digital logic control, micro processors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control. |
| **UNIT-V (8 Hrs)** | System and interfacing and data acquisition, DAQS, SCADA, A to D and D to A conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends. |

| | |
|---|---|
| **Text Books:** | |
| 1. | MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK Vijaya Raghavan/WILEY India Edition/2008 |
| 2. | Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005. |
| | |
| **Reference Books:** | |
| 1. | Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai. |
| 2. | Mechatronics – N. Shanmugam / Anuradha Agencies Publishers. |
| 3. | Mechatronics System Design / Devdasshetty/Richard/Thomson. |
| 4. | Mechatronics/M.D.Singh/J.G.Joshi/PHI. |
| 5. | Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton |
| 6. | Mechatronics – Principles and Application Godfrey C. Onwubolu, Elsevier, 2006 Indian print |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1107** | **PE** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

**INDUSTRIAL ROBOTICS**

**(Program Elective-II)**

**Course Objectives:**

| | |
|---|---|
| 1. | To understand the basic concepts associated with the design and Functioning and applications of Robots |
| 2. | To study about the drives and sensors used in Robots |
| 3. | To learn about analyzing robot kinematics and robot programming |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Distinguish between fixed automation and programmable automation and identify various components of robot. | K2 |
| 2. | Understand the motion analysis of a robot. | K2 |
| 3. | Understand the concepts of end effectorsand machine vision used in Robots. | K2 |
| 4. | Understand the concepts of robot programming and robot languages. | K2 |
| 5. | Illustrate robot applications in manufacturing. | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | INTRODUCTION: Automation and Robotics, Robot anatomy, robot configuration, motions joint notation scheme, work volume, robot drive systems, control systems and dynamic performance, precision of movement. CONTROL SYSTEM AND COMPONENTS: basic concepts and motion controllers, control system analysis, robot actuation and feedback components, Positions sensors, velocity sensors, actuators, power transmission systems, robot joint control design. |
| | |
| **UNIT-II (10 Hrs)** | MOTION ANALYSIS AND CONTROL: Manipulator kinematics, position representation, forward and inverse transformations, homogeneous transformations, manipulator path control, robot arm dynamics, configuration of a robot controller. |
| | |
| **UNIT-III (10 Hrs)** | END EFFECTORS: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design. SENSORS: Desirable features, tactile, proximity and range sensors, uses sensors in robotics. MACHINE VISION: Functions, Sensing and Digitizing-imaging devices, Lighting techniques, Analog to digital single conversion, image storage: Image processing and Analysis-image data reduction, Segmentation, feature extraction, Object recognition. Training the vision system, Robotic application. |
| | |
| **UNIT-IV (8 Hrs)** | ROBOT PROGRAMMING: Lead through programming, Robot program as a path in space, Motion interpolation, WAIT, SIGNAL AND DELAY commands, Branching, capabilities and Limitations of lead through methods. ROBOT LANGUAGES: Textual robot |

| | |
|---|---|
| | Languages, Generations of robot programming languages, Robot language structures, Elements and function. |
| | |
| **UNIT-V (10 Hrs)** | ROBOT CELL DESGIN AND CONTROL: Robot cell layouts-Robot centered cell, In-line robot cell, Considerations in work design, Work and control, Inter locks, Error detection, Work cell controller. ROBOT APPLICATION: Material transfer, Machine loading/unloading, Processing operation, Assembly and Inspection, Future Application. |
| | |

| **Text Books:** | |
|---|---|
| 1. | Industrial Robotics / Groover M P /Pearson Edu. |
| 2. | Introduction to Robotic Mechanics and Control by JJ Craig, Pearson, 3rd edition. |
| | |

| **Reference Books:** | |
|---|---|
| 1. | Robotics / Fu K S/ McGraw Hill. |
| 2. | Robotic Engineering / Richard D. Klafter, Prentice Hall |
| 3. | Robot Analysis and Intelligence / Asada and Slotine / Wiley Inter-Science. |
| 4. | Robot Dynamics & Control – Mark W. Spong and M. Vidyasagar / John Wiley |
| 5. | Introduction to Robotics by SK Saha, The McGrah Hill Company, 6th , 2012 |
| 6. | Robotics and Control / Mittal R K & Nagrath I J / TMH |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19CAD1108 | PE | 3 | 0 | 0 | 3 | 25 | 75 | 3 Hrs. |

**MODELING AND SIMULATION OF MANUFACTURING SYSTEMS**

**(Program Elective-II)**

**Course Objectives:**

| | |
|---|---|
| 1. | To provide knowledge on simulation, simulation steps, parameter estimation and hypothesis. |
| 2. | To provide knowledge on building simulation model how to validation and verification is done. |
| 3. | To provide knowledge on Generation of random variants, variable and some Simulation languages. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understand the concepts of system, elements of systems and types of simulation. | K2 |
| 2. | Classify different discrete and continuous probability distributions. | K2 |
| 3. | Gain knowledge on Generation of random numbers, random variants and variables. | K2 |
| 4. | Build simulation model and also can verify and validate the model. | K3 |
| 5. | Understand the concepts of queining models, markov chain models and game theory. | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Introduction to System and simulation: Concept of system and elements of system, Discrete and continuous system, Models of system and Principles of modeling and simulation, Monte carlo simulation, Types of simulation, Steps in simulation model, Advantages, limitations and applications of simulation, Applications of simulation in manufacturing system |
| **UNIT-II (10 Hrs)** | Review of statistics and probability: Types of discrete and continuous probability distributions such as Geometric, Poisson, Uniform, Geometric distribution with examples, Normal, Exponential distribution with examples. |
| **UNIT-III (10 Hrs)** | Random numbers: Need for RNs, Technique for Random number generation such as Mid product method, Mid square method, and Linear congruential method with examples Test for Random numbers: Uniformity - Chi square test or Kolmogorov Smirnov test, Independency- Auto correlation test Random Variate generation: Technique for Random variate generation such as Inverse transforms technique or Rejection method |
| **UNIT-IV (10 Hrs)** | Analysis of simulation data: Input data analysis, Verification and validation of simulation models, Output data analysis Simulation languages: History of simulation languages, Comparison and selection of simulation languages Design and evaluation of simulation experiments: Development and analysis of simulation models using simulation language with different manufacturing systems |

| | |
|---|---|
| **UNIT-V (8 Hrs)** | Queueing models: An introduction, M/M/1 and M/M/m Models with examples, Open Queueing and Closed queueing network with examples Markov chain models and others: Discrete time markov chain with examples, Continues time markov chain with examples, stochastic process in manufacturing, Game theory |
| | |

| **Text Books:** | |
|---|---|
| 1. | J.Banks, J.S. Carson, B. L. Nelson and D.M. Nicol, ―Discrete Event System Simulation‖,PHI, New Delhi, 2009. |
| 2. | A.M. Law and W.D.Kelton, ―Simulation Modeling and Analysis‖, Tata McGraw Hill Ltd, New Delhi, 2008. |
| | |

| **Reference Books:** | |
|---|---|
| 1. | N. Viswanadham and Y. Narahari, "Performance Modeling of Automated Manufacturing Systems", PHI, New Delhi, 2007. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1109** | **PC** | **0** | **0** | **4** | **2** | **25** | **75** | **3 Hrs.** |

## ADVANCED CAD LAB

**Course Objectives:**

| | |
|---|---|
| 1. | To give exposure to software tools needed to analyse engineering problems. |
| 2. | Expose the students to different applications of simulation and analysis tools. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Perform stress analysis on 2D and 3D Trusses and | K3 |
| 2. | Perform analysis on plates and axi-symmetrical components. | K3 |
| 3. | Execute frequency analysis on beams and 2D components. | K3 |

## LIST OF EXERCISES

Students shall carry out the modeling and FE analysis of the following to predict deflection and stress distributions :

| | |
|---|---|
| 1. | Trussess – 2D and 3D |
| 2. | Beams |
| 3. | Plate with Plane stress condition |
| 4. | Plate with Plane strain condition |
| 5. | Cylinders – Axi-symmetric condition |
| 6. | Natural frequencies of Beam |

**Reference Books:**


| | |
|---|---|
| 1. | CAD/CAM Theory and Practice by Ibrahim Zeid. |
| 2. | CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw Hill Publishing Company Ltd. |
| 3. | CAD/CAM Computer Aided Design and Manufacturing by Mikell P. Groover and Emory W. Zimmer, Jr. |
| 4. | Finite element methods by Chandrupatla & Belagundu. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1110** | **PC** | **0** | **0** | **4** | **2** | **25** | **75** | **3 Hrs.** |

## ADVANCED MANUFACTURING LAB

**Course Objectives:**

| | |
|---|---|
| 1. | To demonstrate the knowledge of basic and advanced Manufacturing Processes. |
| 2. | To demonstrate the knowledge of 3D printing Technology. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Identify and select proper manufacturing process for the manufacturing of parts. | K3 |
| 2. | Manufacture parts using basic and advanced manufacturing processes. | K3 |
| 3. | Build a 3D printed engineering component. | K3 |

**LIST OF EXPERIMENTS**

| | |
|---|---|
| 1. | Casting processes - Study of Solidification, temperatures, metallurgical phases. |
| 2. | Forging processes - Study of hot working processes and extrusion |
| 3. | Forming Processes – Study of blanking, bending and deep drawing |
| 4. | Welding Processes – Study of arc, and spot welding processes |
| 5. | Powder metallurgy- Study of Green Density and sintering density |
| 6. | Additive Manufacturing – Study of simple parts in 3D printing |
| 7. | .Machining- Estimation of chip reduction coefficient and shear angle in orthogonal turning, Measurement of cutting forces and average cutting temperature, and Estimation of tool life of a single point turning tool. |

**Reference Books:**


| | |
|---|---|
| 1. | Manufacturing Engineering and Technology *I* Kalpakijian / Adisson Wesley, 1995. |
| 2. | Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990. |
| 3. | Introduction to Manufacturing Processes / John A Schey *I* Mc Graw Hill. |
| 4. | Advanced Machining Processes / V.K.Jain / Allied Publications. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19RD1101 | RD | 2 | 0 | 0 | 2 | 25 | 75 | 3 Hrs. |

**RESEARCH METHODOLOGY AND IPR**

**(Common to CST,CS,PSA, IT & CAD/CAM)**

**Course Objectives:**

| | |
|---|---|
| 1. | To bring awareness on Research Methodology and research ethics. |
| 2. | Familiarize the concepts of IPR. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Analyze research related information | K4 |
| 2. | Formulate a Research Proposals and Publish papers with research ethics | K6 |
| 3. | Award for Intellectual Property Rights like Patents, Trade and Copyrights | K5 |
| 4. | Analyze Various Intellectual Property Rights | K4 |
| 5. | AssessNew Developments of IPRs in National and International level | K5 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (6 Hrs)** | Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations |
| **UNIT-II (6 Hrs)** | Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee |
| **UNIT-III (6 Hrs)** | Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT. |
| **UNIT-IV (4 Hrs)** | Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. |
| **UNIT-V (6 Hrs)** | New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs. |

**Text Books:**


| | |
|---|---|
| 1. | Stuart Melville and Wayne Goddard, ―Research methodology: an introduction for science & engineering students'‖ |
| 2. | Wayne Goddard and Stuart Melville, ―Research Methodology: An Introduction‖ |
| 3. | Ranjit Kumar, 2nd Edition, ―Research Methodology: A Step by Step Guide for beginners‖ |


**Reference Books:**


| | |
|---|---|
| 1. | Halbert, ―Resisting Intellectual Property‖, Taylor & Francis Ltd, 2007. |
| 2. | Mayall, ―Industrial Design‖, McGraw Hill, 1992. |
| 3. | Niebel, ―Product Design‖, McGraw Hill, 1974. |
| 4. | Asimov, ―Introduction to Design‖, Prentice Hall, 1962. |

| | |
|---|---|
| 5. | Robert P. Merges, Peter S. Menell, Mark A. Lemley, ― Intellectual Property in New Technological Age‖, 2016. |
| 6. | T. Ramappa, ―Intellectual Property Rights Under WTO‖, S. Chand, 2008 |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19AC1109 | AC | 2 | 0 | 0 | 0 | 0 | 0 | -- |

## WRITING SKILLS FOR SCIENTIFIC COMMUNICATION

**Course Objectives:**

| | |
|---|---|
| 1. | To understand the fundamentals of thesis and paper writing. |
| 2. | To Familiarize with Paraphrasing and Plagiarism. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understand that how to improve your writing skills and level of readability | K2 |
| 2. | Learn about what to write in each section | K2 |
| 3. | Understand the skills needed when writing a Title Ensure the good quality of paper at very firsttime submission | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (6 Hrs)** | Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness**,** Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticising. |
| **UNIT-II (6 Hrs)** | Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check. |
| **UNIT-III (6 Hrs)** | Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature. |
| **UNIT-IV (4 Hrs)** | Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions. |
| **UNIT-V (4 Hrs)** | Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission |

**Text Books:**


| | |
|---|---|
| 1. | Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books) |
| 2. | Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press |


**Reference Books:**


| | |
|---|---|
| 1. | Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book. |
| 2. | Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011 |

SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)
(Affiliated to JNTUK, Kakinada), (Recognized by AICTE, New Delhi)
Accredited by NAAC with 'A' Grade
CHINNA AMIRAM (P.O):: BHIMAVARAM :: W.G.Dt., A.P., INDIA :: PIN: 534 204
Estd:1980

**SCHEME OF INSTRUCTION & EXAMINATION**
(Regulation R19)
**M.TECH (CAD/CAM)**
**DEPARTMENT OF MECHANICAL ENGINEERING**
**(**With effect from **2019-2020**Admitted Batch onwards**)**

**II-SEMESTER**

| Code No. | Name of the Subject | Credits | L | T | P | Internal Marks | External Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|
| M19CAD 1201 | Theory of Elasticity and Plasticity | 3 | 3 | 0 | 0 | 25 | 75 | 100 |
| M19CAD 1202 | Advanced Manufacturing Processes | 3 | 3 | 0 | 0 | 25 | 75 | 100 |
| #PE-III | Program Elective-III | 3 | 3 | 0 | 0 | 25 | 75 | 100 |
| #PE-IV | Program Elective-IV | 3 | 3 | 0 | 0 | 25 | 75 | 100 |
| M19CAD 1209 | Computer Aided Machining Lab | 2 | 0 | 0 | 4 | 25 | 75 | 100 |
| M19CAD 1210 | Robotics Lab | 2 | 0 | 0 | 4 | 25 | 75 | 100 |
| M19CAD 1211 | Mini Project With Seminar | 2 | 2 | 0 | 4 | 100 | -- | 100 |
| #AC | Audit Course | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| Total | | **18** | **16** | **0** | **12** | **250** | **450** | **700** |

| | Course Code | Course |
|---|---|---|
| #PE-III | M19CAD 1203 | Advanced Finite Element Methods |
| | M19CAD 1204 | Fracture Mechanics |
| | M19CAD 1205 | Product Design and Development |
| #PE-IV | M19CAD 1206 | Materials Characterization Techniques |
| | M19CAD 1207 | Optimization & Reliability |
| | M19CAD 1208 | Additive Manufacturing |

| | Course Code | Course |
|---|---|---|
| #AC | M19AC 0005 | Constitution of India |
| | M19AC 0006 | Pedagogy studies |
| | M19AC 0008 | Personality development through life enlightenment skills |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1201** | **PC** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

## THEORY OF ELASTICITY AND PLASTICITY

**Course Objectives:**

| | |
|---|---|
| 1. | To make the students understand the concepts of elasticity and equip them with the knowledge to independently handle the problems of elasticity. |
| 2. | To inculcate the habit of researching and practicing in the field of elasticity. |
| 3. | To understand the concepts of plasticity, yield criteria, plastic flow etc., |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Apply to concepts to solve the problems of 3-D elasticity | K3 |
| 2. | Students can independently work with the problems of 2-D elasticity in Cartesian/Polar Coordinates. | K3 |
| 3. | Apply the use of airy's stress function in 2-D problems of elasticity in Cartesian/Polar Coordinates. | K3 |
| 4. | Students will be equipped with the knowledge of various theories of torsion of prismatic bars of various cross sections and can solve the problems of torsion. | K3 |
| 5. | Understand the concepts of plasticity. | K3 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **INTRODUCTION:** Elasticity –Notation for forces and stresses-Components of stresses – components of strain –Hooke's law.<br>**PLANE STRESS AND PLANE STRAIN ANALYSIS:** Plane stress-plane strain-Differential equations of equilibrium- Boundary conditions- Compatibility equations-stress function-Boundary conditions. |
| **UNIT-II (10 Hrs)** | **TWO DIMENSIONAL PROBLEMS IN RECTANGULAR COORDINATES:** Solution by polynomials-Saint Venant's principle-Determination of displacements-bending of simple beams-application of Fourier series for two dimensional problems - gravity loading.<br>**TWO DIMENSIONAL PROBLEMS IN POLAR COORDINATES :**General Equation in polar co-ordinates - stress distribution symmetrical about an axis –Pure bending of curved bars-strain components in polar coordinates-Displacements for symmetrical stress distributions-simple symmetric and asymmetric problems-General solution of two dimensional problem in polar coordinates-Application of the general solution of two dimensional problem in polar coordinates-Application of the general solution in polar coordinates. |
| **UNIT-III (10 Hrs)** | **ANALYSIS OF STRESS AND STRAIN IN THREE DIMENSIONS:** Principle stress - ellipsoid and stress-director surface-Determination of principle stresses- Maximum shear stresses-Homogeneous deformation-principle axis of strain rotation.<br>**GENERAL THEOREMS:** Balance laws - Differential equations of equilibrium- conditions of compatibility - Determination of displacement-Equations of equilibrium in terms of displacements-principle of superposition-Uniqueness of solution –the Reciprocal theorem. |

| | |
|---|---|
| **UNIT-IV (10 Hrs)** | **TORSION OF PRISMATIC BARS:** General solution of problems by displacement (St. Venant's warping function) & force (Prandtl's stress function) approaches - Membrane analogy - Torsion of circular and non-circular (elliptic and rectangular) sections - Torsion of thin rectangular section and hollow thin walled section - Single and multi-celled sections. |
| | |
| **UNIT-V (8 Hrs)** | **THEORY OF PLASTICITY:** Stress-strain curve - Theories of strength and failure –Yield Criteria - Yield Surface – Plastic Flow – Plastic Work – Plastic Potential – Strain hardening |
| | |

| **Text Books:** | |
|---|---|
| 1. | Timoshenko, S., Theory of Elasticity and Plasticity, MC Graw Hill Book company. |
| 2. | Sadhu Singh, Theory of Elasticity and Plasticity, Khanna Publishers. |
| | |

| **Reference Books:** | |
|---|---|
| 1. | Papov, Advanced Strength of materials, MC Graw Hill Book Company. |
| 2. | Chen, W.F. and Han, D.J, Plasticity for structural Engineers, Springer-Verlag, New York. |
| 3. | Lubliner, J., Plasticity Theory, Mac Millan Publishing Co., New York. |
| 4. | Y.C.Fung., Foundations of Solid Mechanics, Prentice Hall India |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19CAD1202 | PC | 3 | 0 | 0 | 3 | 25 | 75 | 3 Hrs. |

**ADVANCED MANUFACTURING PROCESSES**

**Course Objectives:**

| | |
|---|---|
| 1. | To teach the students to understand the fundamentals of manufacturing and prototyping for product design and development. |
| 2. | To teach the students to gain practical experience in manufacturing and prototyping for product design and development. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understand the principles of various surface treatment processes. | K2 |
| 2. | Understand different processing types of ceramics &composite materials. | K2 |
| 3. | Understand the various technologies related to fabrication of microelectronic devices. | K2 |
| 4. | Understand the working principle of various advanced machining processes. | K2 |
| 5. | Understand the concepts of Rapid prototyping and rapid tooling. | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **SURFACE TREATMENT:** Scope, Cleaners, Methods of cleaning, Surface coating types, ceramic and organic methods of coating, and economics of coating. Electro forming, Chemical vapor deposition, Physical vapor deposition, thermal spraying, Ion implantation, diffusion coating, Diamond coating and cladding. |
| **UNIT-II (10 Hrs)** | **PROCESSING OF CERAMICS:** Applications, characteristics, classification .Processing of particulate ceramics, Powder preparations, consolidation, hot compaction, drying, sintering, and finishing of ceramics, Areas of application.<br>**PROCESSING OF COMPOSITES:** Composite Layers, Particulate and fiber reinforced composites, Elastomers, Reinforced plastics, MMC, CMC, Polymer matrix composites. |
| **UNIT-III (10 Hrs)** | **FABRICATION OF MICROELECTRONIC DEVICES:**<br>Crystal growth and wafer preparation, Film Deposition oxidation, lithography, bonding and packaging, reliability and yield, Printed Circuit boards, computer aided design in micro electronics, surface mount technology, Integrated circuit economics. |
| **UNIT-IV (10 Hrs)** | **ADVANCED MACHINING PROCESSES:** AJM, WJM, WireEDM, ECM, LBM, EBM, PAM – Principle, working, limitations and applications. |
| **UNIT-V (8 Hrs)** | **RAPID PROTOTYPING:** Working Principles, Methods, Stereo Lithography, Laser Sintering, Fused Deposition Method, Applications and Limitations, Rapid tooling, Techniques of rapid manufacturing |

| | |
|---|---|
| **Text Books:** | |
| 1. | Manufacturing Engineering and TechnologyI Kalpakijian / Adisson Wesley, 1995. |
| 2. | Process and Materials of Manufacturing / R. A. Lindburg / 1th edition, PHI 1990. |
| | |
| **Reference Books:** | |
| 1. | Microelectronic packaging handbook / Rao. R. Thummala and Eugene, J. Rymaszewski / Van Nostrand Renihold. |
| 2. | MEMS & Micro Systems Design and manufacture / Tai — Run Hsu / TMGH |
| 3. | Advanced Machining Processes / V.K.Jain / Allied Publications. |
| 4. | Introduction to Manufacturing Processes / John A ScheyI Mc Graw Hill. |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1203** | **PE** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

## ADVANCED FINITE ELEMENT METHODS

## (Program Elective-III)

**Course Objectives:**

| | |
|---|---|
| 1. | To introduce nonlinear analysis of structure. |
| 2. | To introduce formulation of dynamic problems in FEM. |
| 3. | To build the ability to model and to solve complex problems in engineering. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Apply variational and weighted residual methods to solve differential equations | K3 |
| 2. | Analyse structural members such as 1-D bar, trusses, beams and framesusing finite element method. | K3 |
| 3. | Analyse two dimensional problems, axi-symmetric problems and heat conduction problems using finite element method. | K3 |
| 4. | Understand the concepts of iso, sub and super parametric formulation and numerical integration. | K2 |
| 5. | Analyse vibration problems for frequencies and mode shapes. | K3 |

## SYLLABUS

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **Formulation Techniques:** Methodology, Engineering problems and governing differential equations, finite elements., Variational methods-potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions. |
| **UNIT-II (10 Hrs)** | **One-dimensional elements:** Bar, trusses, beams and frames, displacements, stresses and temperature effects. |
| **UNIT-III (10 Hrs)** | **Two dimensional problems:** CST, LST, four noded and eight nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Axisymmetric Problems:Axisymmetric formulations, Element matrices, boundary conditions. Heat Transfer problems: Conduction and convection, examples: - two-dimensional fin. |
| **UNIT-IV (10 Hrs)** | **Isoparametric formulation:** Concepts, sub parametric, super parametric elements, numerical integration, Requirements for convergence, h-refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle, Patch test. |
| **UNIT-V (8 Hrs)** | **Finite elements in Structural Analysis:** Static and dynamic analysis, eigen value problems, and their solution methods, case studies using commercial finite element packages. |

| | |
|---|---|
| **Text Books:** | |
| 1. | Finite element methods by Chandrubatla&Belagondu. |
| | |
| **Reference Books:** | |
| 1. | J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press,1994. |
| 2. | Zienckiwicz O.C. & R. L. Taylor, Finite Element Method, McGraw-Hill,1983. |
| 3. | K. J. Bathe, Finite element procedures, Prentice-Hall, 1996. |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1204** | **PE** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

## FRACTURE MECHANICS
## (Program Elective-III)

**Course Objectives:**

| | |
|---|---|
| 1. | To introduce to the concepts of fracture and damage tolerant design usingtheories of fracture. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Determine stress intensity factors by applying Linear Elastic and Elasticplastic fracture mechanics. | K3 |
| 2. | Apply fatigue concepts in predicting the life of Components. | K3 |
| 3. | Formulate and solve problems involving the static, fatigue or impact loading of flawed structures | K3 |

## SYLLABUS

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **Introduction:** Prediction of mechanical failure. Macroscopic failure modes; brittle and ductile behaviour. Fracture in brittle and ductile materials – characteristics of fracture surfaces; inter- granular and intra-granular failure, cleavage and micro-ductility, growth of fatigue cracks, The ductile/brittle fracture transition temperature for notched and unnotched components. Fracture at elevated temperature. |
| **UNIT-II (10 Hrs)** | **Griffiths analysis:** Concept of energy release rate, G, and fracture energy, R. Modification for ductile materials, loading conditions. Concept of R curves.<br>**Linear Elastic Fracture Mechanics, (LEFM):** Three loading modes and the state of stress ahead of the crack tip, stress concentration factor, stress intensity factor and the material parameter the critical stress intensity factor, crack tip plasticity, effect of thickness on fracture toughness. |
| **UNIT-III (10 Hrs)** | **Elastic-Plastic Fracture Mechanics (EPFM):** The definition of alternative failure prediction parameters, Crack Tip Opening Displacement, and the J integral. Measurement of parameters and examples of use. |
| **UNIT-IV (10 Hrs)** | **Fatigue:** definition of terms used to describe fatigue cycles, High Cycle Fatigue, Low Cycle Fatigue, mean stress R ratio, strain and load control. S-N curves. Goodmans rule and Miners rule. Micro-mechanisms of fatigue damage, fatigue limits and initiation and propagation control, leading to a consideration of factors enhancing fatigue resistance. Total life and damage tolerant approaches to life prediction. |
| **UNIT-V (8 Hrs)** | **Creep deformation:** the evolution of creep damage, primary, secondary and tertiary creep. Micro-mechanisms of creep in materials and the role of diffusion. Ashby creep deformation maps. Stress dependence of creep – power law dependence. Comparison of creep performance under different conditions – extrapolation and the use of Larson-Miller parameters. Creep-fatigue interactions. Examples. |

**Text Books:**


| | |
|---|---|
| 1. | T.L. Anderson, Fracture Mechanics Fundamentals and Applications, 2nd Ed. CRC press, (1995) |
| 2. | J.F. Knott, Fundamentals of Fracture Mechanics, Butterworths (1973). |

| | |
|---|---|
| 3. | G. E. Dieter, Mechanical Metallurgy, McGraw Hill, (1988) |
| 4. | S. Suresh, Fatigue of Materials, Cambridge University Press, (1998) |
| | |
| **Reference Books:** | |
| 1. | B. Lawn, Fracture of Brittle Solids, Cambridge Solid State Science Series 2nd ed1993. |
| 2. | J.F. Knott, P Withey, Worked examples in Fracture Mechanics, Institute of Materials |
| 3. | H.L.Ewald and R.J.H. Wanhill Fracture Mechanics, Edward Arnold, (1984). |
| 4. | L.B. Freund and S. Suresh, Thin Film Materials Cambridge University Press,(2003). |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1205** | **PE** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

**PRODUCT DESIGN AND DEVELOPMENT**

**(Program Elective-III)**

**Course Objectives:**

| | |
|---|---|
| 1. | To impart the process of product design and Development |
| 2. | To expose the various factors influencing product design. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Identify and analyse the product design and development processes in manufacturing industry. | K3 |
| 2. | Define the components and their functions of product design and development processes and their relationships from concept to customer over whole product lifecycle. | K3 |
| 3. | Analyse, evaluate and apply the methodologies for product design, development and management. | K3 |
| 4. | Undertake a methodical approach to the management of product development to satisfy customer needs. | K3 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Introduction:Classification/Specifications of Products, Product life cycle. Product mix, Introduction to product design, Modern product development process, Innovative thinking. |
| **UNIT-II (10 Hrs)** | Morphology of design. Conceptual Design: Generation, selection & embodiment of concept.Product architecture, Industrial design: process, need, Robust Design: Taguchi Designs & DOE, Design Optimization. |
| **UNIT-III (10 Hrs)** | Design for Mfg& Assembly: Methods of designing for Manufacturing and assembly, Designs for Maintainability, Designs for Environment, Product costing, Legal factors and social issues, Engineering ethics and issues of society related to design of products. Value Engineering / Value Analysis. : Definition. Methodology, Case studies. |
| **UNIT-IV (8 Hrs)** | Economic analysis: Qualitative & Quantitative. Ergonomics / Aesthetics: Gross human autonomy, Anthropometry, Man-Machine interaction, Concepts of size and texture, colour .Comfort criteria, Psychological & Physiological considerations. |
| **UNIT-V (10 Hrs)** | Creativity Techniques: Creative thinking, conceptualization, brain storming, primary design, drawing, simulation, detail design. Concurrent Engineering, Rapid prototyping, Tools for product design – Drafting / Modeling software, CAM Interface, Patents & IP Acts. Overview, Disclosure preparation. |

**Text Books:**


| | |
|---|---|
| 1. | Karl T Ulrich, Steven D Eppinger , " Product Design & Development." Tata McGrawhill New Delhi 2003. |
| 2. | David G Ullman, "The Mechanical Design Process." McGrawhill Inc Singapore 1992. |
| 3. | N J M Roozenberg , J Ekels , N F M Roozenberg "Product Design Fundamentals and Methods" John Willey & Sons 1995. |


**Reference Books:**

| | |
|---|---|
| 1. | Hollins B & Pugh S “Successful Product Design.” Butter worth London. |
| 2. | Jones J C “Design Methods.” Seeds of Human Futures. John Willey New York. |
| 3. | Bralla J G “Handbook of Product Design for Manufacture, McGrawhill NewYork. |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1206** | **PC** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

**MATERIALS CHARACTERIZATION TECHNIQUES**

**(Program Elective-IV)**

**Course Objectives:**

| | |
|---|---|
| 1. | To introduce the students to the principles of optical and electron microscopy, X-ray diffraction and various spectroscopic techniques |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Apply appropriate characterization techniques for microstructure examination at different magnification level and use them to understand the microstructure of various materials | K3 |
| 2. | Choose and appropriate electron microscopy techniques to investigate microstructure of materials at high resolution | K3 |
| 3. | Understand the principles of various thermal analysis techniques | K2 |
| 4. | Understand the principles of Magnetic characterization techniques | K2 |
| 5. | Understand the principles ofOptical and electronic characterization techniques. | K3 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Introduction to materials and Techniques,Structure analysis tools: X-ray diffraction: phase identification, indexing and lattice parameter determination, Analytical line profile fitting using various models, Neutron diffraction, Reflection High Energy Electron Diffraction, and Low Energy Electron Diffraction. |
| **UNIT-II (10 Hrs)** | Microscopy techniques: Optical microscopy, transmission electron microscopy (TEM), energy dispersive X-ray microanalysis (EDS), scanning electron microscopy (SEM), Rutherford backscattering spectrometry (RBS), atomic force microscopy (AFM) and scanning probe microscopy (SPM). |
| **UNIT-III (10 Hrs)** | Thermal analysis technique: Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermogravimetric analysis (TGA); Electrical characterization techniques: Electrical resistivity, Hall effect, Magnetoresistance. |
| **UNIT-IV (10 Hrs)** | Magnetic characterization techniques: Introduction to Magnetism, Measurement Methods, Measuring Magnetization by Force, Measuring Magnetization by Induction method, Types of measurements using magnetometers: M-H loop, temperature dependent magnetization, time dependent magnetization, Measurements using AC susceptibility, Magneto-optical Kerr effect, Nuclear Magnetic Resonance, Electron Spin Resonance. |
| **UNIT-V (8 Hrs)** | Optical and electronic characterization techniques: UV-VIS spectroscopy, Fourier transform infrared spectroscopy, Raman spectroscopy, X-ray photoelectron spectroscopy. |

**Text Books:**


| | |
|---|---|
| 1. | Characterization of Materials (Materials Science andTechnology:A Comprehensive Treatment, Vol 2A & 2B,VCH (1992). |
| 2. | Semiconductor Material and Device Characterization, 3rdEdition, D. K. Schroder, Wiley-IEEE Press (2006). |
| 3. | Materials Characterization Techniques, S Zhang, L. Li andshok Kumar, CRC Press (2008). |

| Reference Books: | |
|---|---|
| 1. | Physical methods for Materials Characterization, P. E. J.Flewitt and R K Wild, IOP Publishing (2003). |
| 2. | Characterization of Nanophase materials, Ed. Z L Wang,Willet-VCH (2000). |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19CAD1207 | PE | 3 | 0 | 0 | 3 | 25 | 75 | 3 Hrs. |

**OPTIMIZATION & RELIABILITY**

**(Program Elective-IV)**

**Course Objectives:**

| | |
|---|---|
| 1. | To understand the theory of optimization methods and algorithms developed for solving various types of optimization problems. |
| 2. | To develop and promote research interest in applying optimization techniques and reliability concepts in problems of Engineering and Technology. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understanding the concepts of conventional, unconventional optimization algorithms. | K2 |
| 2. | Formulate engineering design problems as mathematical optimization problems and solve them by using suitable optimization techniques. | K3 |
| 3. | Understand the concepts of Genetic Algorithm, Genetic programing and multi objective Genetic Algorithm. | K2 |
| 4. | Apply the concepts of optimization in design and manufacturing. | K3 |
| 5. | Understand the basic concepts of reliability. | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **CLASSICAL OPTIMIZATION TECHNIQUES:** Single variable optimization with and without constraints, multi – variable optimization without constraints, multi – variable optimization with constraints – method of Lagrange multipliers, Kuhn-Tucker conditions, merits and demerits of classical optimization techniques. |
| **UNIT-II (10 Hrs)** | **NUMERICAL METHODS FOR OPTIMIZATION:** Nelder Mead's Simplex search method, Gradient of a function, Steepest descent method, Newton's method, Pattern search methods, conjugate method, types of penalty methods for handling constraints, advantages of numerical methods. |
| **UNIT-III (10 Hrs)** | **GENETIC ALGORITHM (GA) :** Differences and similarities between conventional and evolutionary algorithms, working principle, reproduction, crossover, mutation, termination criteria, different reproduction and crossover operators, GA for constrained optimization, draw backs of GA,<br>**GENETIC PROGRAMMING (GP):** Principles of genetic programming, terminal sets, functional sets, differences between GA & GP, random population generation, solving differential equations using GP.<br>**MULTI-OBJECTIVE GA:** Pareto's analysis, Non-dominated front, multi – objective GA, Non-dominated sorted GA, convergence criterion, applications of multi-objective problems. |
| **UNIT-IV (10 Hrs)** | **APPLICATIONS OF OPTIMIZATION IN DESIGN AND MANUFACTURING SYSTEMS:** Some typical applications like optimization of path synthesis of a four-bar mechanism, minimization of weight of a cantilever beam, optimization of springs and gears, general optimization model of a machining process, optimization of arc welding parameters, and general procedure in optimizing machining operations sequence. |

| | |
|---|---|
| **UNIT-V (8 Hrs)** | **RELIABILITY:** Concepts of Engineering Statistics, risk and reliability, probabilistic approach to design, reliability theory, design for reliability, numerical problems, hazard analysis. |
| | |

| **Text Books:** | |
|---|---|
| 1. | Optimization for Engineering Design – Kalyanmoy Deb, PHI Publishers. |
| 2. | Engineering Optimization – S.S.Rao, New Age Publishers. |
| 3. | Reliability Engineering by L.S.Srinath |
| 4. | Multi objective genetic algorithm by Kalyanmoy Deb, PHI Publishers. |
| | |

| **Reference Books:** | |
|---|---|
| 1. | Genetic algorithms in Search, Optimization, and Machine learning – D.E.Goldberg, Addison-Wesley Publishers. |
| 2. | Multi objective Genetic algorithms - Kalyanmoy Deb, PHI Publishers. |
| 3. | Optimal design – Jasbir Arora, Mc Graw Hill (International) Publishers. |
| 4. | An Introduction to Reliability and Maintainability Engineering by CE Ebeling, Waveland Printers Inc., 2009. |
| 5. | Reliability Theory and Practice by I Bazovsky, Dover Publications, 2013. |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1208** | **PE** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

## ADDITIVE MANUFACTURING
## (Program Elective-IV)

**Course Objectives:**

| | |
|---|---|
| 1. | To introduce students the basics of additive manufacturing/rapid prototyping and its applications in various fields, reverse engineering techniques. |
| 2. | To familiarize students with different processes in rapid prototyping systems. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understand the concepts of Additive Manufacturing and Rapid Prototyping technologies.. | K2 |
| 2. | Classify and explain principles of various machines used for rapid prototyping. | K2 |
| 3. | Understand the concepts of tooling processes and direct rapid tooling processes. | K2 |

## SYLLABUS

| | |
|---|---|
| **UNIT-I (10 Hrs)** | Additive Manufacturing Process: Basic Principles of the Additive Manufacturing Process, Generation of Layer Information, Physical Principles for Layer Generation. Elements for Generating the Physical Layer, Classification of Additive Manufacturing Processes, Evaluation of the Theoretical Potentials of Rapid Prototyping Processes. |
| **UNIT-II (10 Hrs)** | Machines for Rapid Prototyping: Overview of Polymerization: Stereolithography (SL), Sintering/Selective Sintering: Melting in the Powder Bed, Layer Laminate Manufacturing (LLM) and Three-Dimensional Printing (3DP). |
| **UNIT-III (10 Hrs)** | Rapid Prototyping: Classification and Definition, Strategic Aspects for the Use of Prototypes, Applications of Rapid Prototyping in Industrial Product Development. Rapid Tooling: Classification and Definition of Terms, Properties of Additive Manufactured Tools, Indirect Rapid |
| **UNIT-IV (10 Hrs)** | Tooling Processes: Molding Processes and Follow-up Processes, Indirect Methods for the Manufacture of Tools for Plastic Components, Indirect Methods for the Manufacture of Metal Components. |
| **UNIT-V (8 Hrs)** | Direct Rapid Tooling Processes: Prototype Tooling: Tools Based on Plastic Rapid Prototyping Models and Methods, Metal Tools Based on Multilevel AM Processes, Direct Tooling: Tools Based on Metal Rapid Prototype Processes. |

**Text Books:**


| | |
|---|---|
| 1. | Andreas Gebhardt Jan-Steffen Hötter, Additive Manufacturing: 3D Printing for Prototyping and Manufacturing, Hanser Publications, 6915 Valley Avenue, Cincinnati, Ohio. |
| 2. | Ian Gibson, David Rosen, Brent Stucker, Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Second Edition, Springer New York Heidelberg Dordrecht London. |

| **Reference Books:** | |
|---|---|
| 1. | Liou L.W. and Liou F.W., "Rapid Prototyping and Engineering applications : A tool box for prototype development", CRC Press, 2007. |
| 2. | Kamrani A.K. and Nasr E.A., "Rapid Prototyping: Theory and practice", Springer, 2006. |
| 3. | Hilton P.D. and Jacobs P.F., "Rapid Tooling: Technologies and Industrial Applications", CRC press, 2000. |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1209** | **PC** | **0** | **0** | **4** | **2** | **25** | **75** | **3 Hrs.** |

## COMPUTER AIDED MACHINING LAB

**Course Objectives:**

| | |
|---|---|
| 1. | To analyze features of CNC machines and machining centres. |
| 2. | To create steps and commands in part programming and tool selection. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Demonstrate part programming for CNC lathe and mill and execute the same for the part production. | K4 |
| 2. | Develop the manufacturing of components through CAM Software | K5 |

**LIST OF EXERCISES**

| | |
|---|---|
| 1. | Introduction to Manual part programming and features of CNC Turning and Milling Centres. |
| 2. | Preparation of manual part programme for Turning and drilling operations using point-topoint, Linear and circular interpolation Techniques. |
| 3. | Preparation of manual part programme for Milling operations using point-to-point, Linear and circular interpolation Techniques. |
| 4. | Part programming using Fixed or Canned Cycles for Drilling, Peck drilling, Boring, Tapping and Thread cutting operations. |
| 5. | Generation of Tool path, NC code and its Simulation for Turning and Milling operations using any one CAM packages like EdgeCAM, MasterCAM and Off-line NC simulation softwares. |
| 6. | Computer Assisted Part Programme generation using APT language. |
| 7. | Machining of simple components on CNC lathe machine |
| 8. | Machining of simple components on CNC Milling machine |

**Reference Books:**


| | |
|---|---|
| 1. | CAD/CAM Theory and Practice by Ibrahim Zeid. |
| 2. | CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw Hill Publishing Company Ltd. |
| 3. | CAD/CAM Computer Aided Design and Manufacturing by Mikell P. Groover and Emory W. Zimmer, Jr. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1210** | **PC** | **0** | **0** | **4** | **2** | **25** | **75** | **3 Hrs.** |

## ROBOTICS LAB

**Course Objectives:**

| | |
|---|---|
| 1. | Familiarize simulation of dynamic systems and robots, and control such systems. |
| 2. | Impart practical knowledge on robotic manipulators and programming of industrial manipulators. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understand the dynamic simulation of robot manipulator using MATLAB. | K5 |
| 2. | Learn the dynamic modeling and control of robot manipulator using Simulink. | K5 |
| 3. | Develop in-depthknowledge of forward and inverse kinematics and dynamicsusing open source robot software. | K5 |
| 4. | Learn and gain practical knowledge of different components of physical robot. | K5 |
| 5. | Understand programming of robot manipulator for various operations. | K5 |

**LIST OF EXPERIMENTS**

| | |
|---|---|
| 1. | Introduction to programming in MATLAB. |
| 2. | Introduction to Simulink**:** Modeling and simulation of spring-mass-damper system. |
| 3. | Modeling and simulation of 2-R manipulator using Simulink. |
| 4. | Development of PID control for DC motor. |
| 5. | Joint space and and work space control of 2R manipulator. |
| 6. | Forward and Inverse kinematics of robot manipulator using Robo-Analyzer software |
| 7. | Pick and place operation using a 4-DOF robotic manipulator. |
| 8. | Collaborative manipulation using two robotic manipulators. |

**Reference Books:**


| | |
|---|---|
| 1. | Introduction to Robotics by S.K. Saha, The McGrah Hill Company, 6th, 2012. |
| 2. | MATLAB and Simulink for Engineers by Agam Kumar Tyagi, Oxford Higher Education, 2011. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD1211** | **MP** | **0** | **0** | **4** | **2** | **100** | **--** | **3 Hrs.** |
| **MINI PROJECT WITH SEMINAR** | | | | | | | | |
| For **Mini Project with Seminar**, a student under the **supervision of a faculty member**, shall collect the **literature on a topic and critically review the literature** and submit it to the department in a **report form** and shall make an **oral presentation** before the **Project Review Committee consisting of Head of the Department, supervisor/mentor and two other senior faculty members** of the department. For Mini Project with Seminar, there will be only **internal evaluation of 100 marks**. A candidate has to secure a minimum of **50% of marks** to be declared successful. | | | | | | | | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19AC0005 | AC | 2 | 0 | 0 | 0 | 0 | 0 | -- |

## CONSTITUTION OF INDIA

**Course Objectives:**

| | |
|---|---|
| 1. | Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. |
| 2. | To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism |
| 3. | To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1 | Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics. | K2 |
| 2 | Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India. | K2 |
| 3 | Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution. | K2 |
| 4 | Discuss the passage of the Hindu Code Bill of 1956. | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (4Hrs)** | **History of Making of the Indian Constitution:** History , Drafting Committee, ( Composition & Working) |
| **UNIT-II (4Hrs)** | Philosophy of the Indian Constitution: Preamble ,Salient Features |
| **UNIT-III (6Hrs)** | Fundamental Rights,Right to Equality, Right to Freedom,Right against Exploitation, Right to Freedom of Religion,Cultural and Educational Rights,Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties |
| **UNIT-IV (8Hrs)** | **Organs of Governance:** Parliament, Composition, Qualifications and Disqualifications ,Powers and Functions, Executive, President , Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions **Local Administration:** District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: Zilla Panchayat. Elected officials and their roles, CEO Zilla Panchayat: Position and role. Block level: Organizational Hierarchy (Different departments),Village level: Role of Elected and Appointed officials, Importance of grass root democracy |
| **UNIT-V (6Hrs)** | **Election Commission:** Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners. State Election Commission: Role and Functioning. Institute and Bodies for the welfare of SC/ST/OBC and women. |

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

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19AC0006** | **AC** | **2** | **0** | **0** | **0** | **0** | **0** | **--** |

**PEDAGOGY STUDIES**

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (6Hrs)** | **Introduction and Methodology:** Aims and rationale, Policy background, Conceptual framework and terminology Theories of learning, Curriculum, Teacher education. Conceptual framework, Research questions**.** Overview of methodology and Searching. |
| | |
| **UNIT-II (4Hrs)** | Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education. |
| | |
| **UNIT-III (6Hrs)** | Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included studies. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy. |
| | |
| **UNIT-IV (6Hrs)** | Theory of change, Strength and nature of the body of evidence for effective pedagogical practices Pedagogic theory and pedagogical approaches. Teachers' attitudes and beliefs and Pedagogic strategies. Professional development: alignment with classroom practices andfollow-up support |
| | |
| **UNIT-V (4Hrs)** | **Research gaps and future directions:** Research design, Contexts,Pedagogy,Teachereducation,Curriculum and assessment,Dissemination and research impact. |

**Text Books:**


| | |
|---|---|
| 1. | Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261. |
| 2. | Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379. |
| 3. | Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education research project (MUSTER) country report 1. London: DFID. |
| 4. | Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basicmaths and reading in Africa: Does teacher preparation count? International Journal of Educational Development, 33 (3): 272–282. |
| 5. | Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education.Oxford and Boston: Blackwell. |
| 6. | Chavan M (2003) Read India: A mass scale, rapid, „learning to read" campaign. |
| 7. | www.pratham.org/images/resource%20working%20paper%202.pdf. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19AC0008** | **AC** | **2** | **0** | **0** | **0** | **0** | **0** | **--** |

**PERSONALITY DEVELOPMENT THROUGH LIFEENLIGHTENMENT SKILLS**

**Course Objectives:**

| | |
|---|---|
| 1. | To learn to achieve the highest goal happily |
| 2. | To become a person with a stable mind, pleasing personality and determination |
| 3. | To awaken wisdom in students |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1 | Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life. | K2 |
| 2 | The person who has studied Geeta will lead the nation and mankind to peace and prosperity. | K2 |
| 3 | Study of Neetishatakam will help in developing versatile personality of students. | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (6Hrs)** | Neetisatakam-Holistic development of personality<br>Verses- 19,20,21,22 (wisdom)<br>Verses- 29,31,32 (pride & heroism)<br>Verses- 26,28,63,65 (virtue) |
| **UNIT-II (6Hrs)** | Neetisatakam-Holistic development of personality<br>Verses- 52,53,59 (dont's)<br>Verses- 71,73,75,78 (do's)<br>Approach to day to day work and duties.<br>Shrimad Bhagwad Geeta : Chapter 2-Verses 41, 47,48, |
| **UNIT-III (4Hrs)** | Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,<br>Chapter 18-Verses 45, 46, 48. |
| **UNIT-IV (6Hrs)** | Statements of basic knowledge.<br>Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68<br>Chapter 12 -Verses 13, 14, 15, 16,17, 18 |
| **UNIT-V (6Hrs)** | Personality of Role model. Shrimad Bhagwad Geeta: Chapter2-Verses 17, Chapter 3-Verses 36,37,42,<br>Chapter 4-Verses 18, 38,39<br>Chapter18 – Verses 37,38,63 |

**Text Books:**

| | |
|---|---|
| 1. | 'Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (PublicationDepartment), Kolkata |
| 2. | Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath,Rashtriya Sanskrit Sansthanam, New Delhi. |

SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE
(AUTONOMOUS)
(Affiliated to JNTUK, Kakinada), (Recognized by AICTE, New Delhi)
Accredited by NAAC with 'A' Grade, All UG Programmes are accredited by NBA
CHINNA AMIRAM (P.O):: BHIMAVARAM :: W.G.Dt., A.P., INDIA :: PIN: 534 204
Estd:1980

**SCHEME OF INSTRUCTION & EXAMINATION**
(Regulation R19)
**M.TECH (CAD/CAM)**
**DEPARTMENT OF MECHANICAL ENGINEERING**
**(**With effect from **2019-2020**Admitted Batch onwards**)**

**III-SEMESTER**

| Code No. | Name of the Subject | Credits | Lec-ture Hrs | Tutorial Hrs | Lab Hrs | Contact Hrs/ Week | Internal Marks | External Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| #PE-V/ MOOCS | Program Elective-V | 3 | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| #OE/MOOCS | Open Elective | 3 | 3 | 0 | 0 | 3 | 25 | 75 | 100 |
| M19CAD2106 | **Dissertation-I / Industrial Project** | 10 | 0 | 0 | 20 | 20 | 50 | 50 | 100 |
| Total | | **16** | **6** | **0** | **20** | **26** | **100** | **200** | **300** |

| | Course Code | Course |
|---|---|---|
| **#PE-V/ MOOCS** | M19CAD 2101 | Non Destructive Evaluation |
| | M19CAD 2102 | Quality Engineering |
| | M19CAD 2103 | Green Manufacturing |
| | M19CAD 2104 (MOOCS-I) | Students Going for Industrial Project / Thesis will complete these courses through MOOCS. Students can also choose SWAYAM or NPTEL with a 12 weeks' course duration in PG level with 3 credits, but the chosen subject should not be covered in their M. Tech Course |
| **#OE/ MOOCS** | #OE | Students have to choose one open elective course offered by departments other than the parent department.<br>List of open Electives offered by other departments are enclosed. |
| | M19CAD 2105 (MOOCS-II) | Students Going for Industrial Project / Thesis will complete these courses through MOOCS. Students can also choose SWAYAM or NPTEL with a 12 weeks' course duration in PG level with 3 credits, but the chosen subject should not be covered in their M. Tech Course |

| **OPEN ELECTIVES OFFERED TO OTHER DEPARTMENTS** | |
|---|---|
| M19CAD 2107 | Operations Research |
| M19CAD 2108 | Nano Technology |
| M19CAD 2109 | Product Design & Manufacturing |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19CAD2101 | PE | 3 | 0 | 0 | 3 | 25 | 75 | 3 Hrs. |

**NON DESTRUCTIVE EVALUATION**

**(Program Elective-V)**

**Course Objectives:**

| | |
|---|---|
| 1. | To introduce the concept of non-destructive testing among the students |
| 2. | Make students to understand various types of non-traditional practices available for manufacturing industry in testing.. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | The student shall be able to select an appropriate NDT technique as per requirement. | K3 |
| 2. | Understand the theoretical and practical aspects of the radiographic testing, interpretation and evaluation. | K2 |
| 3. | Acquire basic knowledge of ultrasonic testing which enables them to perform inspection of samples. | K3 |
| 4. | Understand the principle of optical holography and its applications in NDT. | K3 |
| 5. | Apply various NDTs for flaw analysis of pressure vessels, piping, welded joints, casted parts. | K3 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | General Methods: Flaw Detection Using Dye Penetrants. Magnetic Particle Inspection, introduction to electrical impedance, Principles of Eddy Current testing, Flaw detection using eddy currents. |
| **UNIT-II (10 Hrs)** | X-Ray Radiography: The Radiographic process, X-Ray and Gamma-ray sources, Geometric Principles, Factors Governing Exposure, Radio graphic screens, Scattered radiation, Arithmetic of exposure, Radiographic image quality and detail visibility, Industrial X-Ray films, Fundamentals of processing techniques, Process control, The processing Room, Special Processing techniques, Paper Radiography, Sensitometric characteristics of x-ray films, Film graininess signal to noise ratio in radiographs, The photographic latent image, Radiation Protection. |
| **UNIT-III (10 Hrs)** | Generation of ultrasonic waves, Horizontal and shear waves, Near field and far field acoustic wave description, Ultrasonic probes- straight beam, direct contact type, Angle beam, Transmission/reflection type, and delay line transducers, acoustic coupling and media, Transmission and pulse echo methods, A-scan, B-scan, C-scan, F-scan and P-scan modes, Flaw sizing in ultrasonic inspection: AVG, Amplitude, Transmission, TOFD, Satellite pulse, Multi- modal transducer, Zonal method using focused beam. Flow location methods, Signal processing in Ultrasonic NDT; Mimics, spurious echos and noise. Ultrasonic flaw evaluation. |
| **UNIT-IV (8 Hrs)** | Holography: Principles and practices of Optical holography, acoustical, microwave, x-ray and electron beam holography techniques. |
| **UNIT-V** | Applications: NDT in flaw analysis of Pressure vessels, piping, NDT in Castings, Welded |

| | |
|---|---|
| **(8 Hrs)** | constructions, etc., Case studies. |
| | |
| **Text Books:** | |
| 1. | Ultrasonic testing by Krautkramer and Krautkramer |
| 2. | Ultrasonic inspection Training for NDT : E. A. Gingel, Prometheus Press. |
| | |
| **Reference Book:** | |
| 1. | ASTM Standards, Vol 3.01, Metals and alloys |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| M19CAD2102 | PE | 3 | 0 | 0 | 3 | 25 | 75 | 3 Hrs. |

**QUALITY ENGINEERING**

**(Program Elective-V)**

**Course Objective:**

| | |
|---|---|
| 1. | Demonstrate the approaches and techniques to assess and improve process and/or product quality. |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understand the concepts of Quality value and Engineering. | K2 |
| 2. | Understand the concepts of Tolerance design and tolerancing. | K2 |
| 3. | Understand the principles of DOE and ANOVA. | K2 |
| 4. | Understand the concepts of orthogonal arrays. | K2 |
| 5. | Understand the principles of six sigma and the technical system. | K2 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **QUALITY VALUE AND ENGINEERING:** An overall quality system, quality engineering in production design, quality engineering in design of production processes. Loss Function and Quality Level: Derivation and use of quadratile loss function, economic consequences of tightening tolerances as a means to improve quality, evaluations and types tolerances.(N-type,S-type and L-type) |
| **UNIT-II (10 Hrs)** | **TOLERANCE DESIGN AND TOLERANCING:** Functional limits, tolerance design for N-type. L-type and S-type characteristics, tolerance allocation for multiple components. Parameter and Tolerance Design: Introduction to parameter design, signal to noise ratios, Parameter design strategy, some of the case studies on parameter and tolerance designs. |
| **UNIT-III (10 Hrs)** | **DOE:** DOE process steps, Observation method, Ranking method, Column effects method and Plotting method.<br>**ANALYSIS OF VARIANCE (ANOVA):** Introduction to ANOVA, Need for ANOVA, NO-way ANOVA, One-way ANOVA, Two-way ANOVA, Critique of F-test, ANOVA for four level factors, multiple level factors. |
| **UNIT-IV (10 Hrs)** | **ORTHOGONAL ARRAYS:** Typical test strategies, better test strategies, efficient test strategies, steps in designing, conducting and analyzing an experiment. Interpolation of Experimental Results: Interpretation methods, percent contributor, estimating the mean. |
| **UNIT-V (8 Hrs)** | **SIX SIGMA AND THE TECHNICAL SYSTEM:** Six sigma DMAIC methodology, tools for process improvement, six sigma in services and small organizations, statistical foundations, statistical methodology. |

**Text Book:**

| | |
|---|---|
| 1. | Taguchi Techniques for Quality Engineering / Phillip J. Ross / McGraw Hill/ Intl. II Edition, 1995. |

| **Reference Books:** | |
|---|---|
| 1. | Quality Engineering in Production systems by G. Taguchi, A. Elsayed et al, McGraw Hill Intl. Pub 1989. |
| 2. | Taguchi Methods explained: Practical steps to Robust Design / Papan P. Bagchi I Prentice Hall Pvt. Ltd., New Delhi. |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD2103** | **PE** | **3** | **0** | **0** | **3** | **25** | **75** | **3 Hrs.** |

**GREEN MANUFACTURING**

**(Program Elective-V)**

**Course Objective:**

| | |
|---|---|
| 1. | Acquire a broad understanding of sustainable manufacturing, green product and process. |
| 2. | Understand the analytical tools, techniques in green manufacturing |

**Course Outcomes**

| S.No | Outcome | Knowledge Level |
|---|---|---|
| 1. | Understand the basic design concepts, methods, tools, the key technologies and the operation of sustainable green manufacturing. | K2 |
| 2. | Understand the basic concepts of green manufacturing tools. | K2 |
| 3. | Understand the basic concepts of various attributes decision making methods. | K2 |
| 4. | Identify the strategies for the purpose of satisfying a set of given sustainable green manufacturing requirements | K3 |
| 5. | Design the rules and processes to meet the market need and the green manufacturing requirements by selecting and evaluating suitable technical, managerial/project management and supply chain management scheme. | K3 |

**SYLLABUS**

| | |
|---|---|
| **UNIT-I (10 Hrs)** | **INTRODUCTION TO MANUFACTURING** Definition of manufacturing, Impact of manufacturing in environmental ecology, Role of manufacturing sector in national growth, Technological change and evolving risk , concepts of "green" manufacturing need of green manufacturing ,Green manufacturing strategies , Green manufacturing – motivation, barriers, regulation, policy , Casting defects and remedies. , Advantages and limitations of green manufacturing. |
| | |
| **UNIT-II (10 Hrs)** | **GREEN MANUFACTURING TOOLS** Principles of green manufacturing and its efficiency, Green manufacturing and sustainability , System model architecture and module, Design and planning, control or tools for green manufacturing (Qualitative Analysis, Consumption Analysis, Life Cycle Analysis, Efficiency, Sustainability tools) Standards for green manufacturing (ISO 14000 and OHSAS 18000 , Waste stream mapping and application Identify and apply the concepts of product and process design with environmental forethought, Design for environment and for sustainability -Discuss the Product Life Cycle of manufactured goods. |
| | |
| **UNIT-III (10 Hrs)** | **ATTRIBUTES DECISION MAKING METHODS** Introduction to Multi attributes decision making methods, definition, structure for Multi attributes decision making, Reference methods variants and analysis of different methods like Simple Additive Method (SAM) Weighted Product Method (WPM. Analytic Hierarchy Process (AHP) Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS), Grey Relation Analysis (GRA Elimination and Choice Expressing Reality (ELECTRE) ViseKriterijumska Optimizacija I Kompromisno Resenje (VIKOR), Problems based on different MADMs. |

| | |
|---|---|
| | |
| **UNIT-IV (10 Hrs)** | **CREATING LEAN AND GREEN ORGANISATION** Question wasteful practices Gain lean and green endorsement, collaboration to achieve lean and green goals Track progress for environment and profits Creation of sustainable growth Enabling techniques for assuring green manufacturing, Drivers of green manufacturing, impact, advantages and disadvantages of drivers, Green architecture and buildings, Sustainable manufacturing resources management , Carbon footprint analysis and management of manufacturing processes , Green Process Economics, Resource Recovery and Reuse. |
| | |
| **UNIT-V (8 Hrs)** | **CASE STUDIES IN GREEN MANUFACTURING** Design resources saving into product and processes , Closed loop & Open Loop production system , Green manufacturing through clean energy supply , semiconductors manufacturing , Various case studies of implementation of semiconductors manufacturing at industries , Green packaging and supply chain, Various case studies of implementation of Optimizing Logistics solution at industries , Environmental implication of Nanomanufacturing , Various case studies of implementation of lean manufacturing at industries Various case studies of implementation of Optimizing process or product at industries. |
| | |

| **Text Books:** | |
|---|---|
| 1. | Ronald G. Askin & Jeffrey B. Goldberg, "Design and Analysis of Lean Production Systems", John Wiley & Sons, 2003. |
| 2. | Rao.P.N, "Manufacturing Technology, Vol I and II", Tata McGraw Hill Publishing Co., 3rd edition, Sixth Reprint 2010 |
| | |
| **Reference Books:** | |
| 1. | Charles Wankel "21st century management: a reference handbook" SAGE Publications, Inc., 2008. |
| 2. | Christian N. Madu "Handbook of environmentally conscious manufacturing" London : Kluwer Academic Publishers, 2001. |
| 3. | T.E. Graedel & B.R. Allenby "Industrial Ecology" Pearson Education, Inc. 2003. |
| 4. | Joseph Sarkis "Greener manufacturing and operations: from design to delivery and back" Greenleaf Pub., 2001. |
| 5. | Ranky, P.G.: "An Introduction to Alternative Energy Sources: An interactive multimedia 3D eBook publication by CIMware USA, Inc. and CIMware Ltd., UK, ISBN 1-872631- 97-5, 2008. |
| | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD2104** | **PE** | **3** | **0** | **--** | **3** | **25** | **75** | **3 Hrs.** |
| | | | | | | | | |
| **MOOCS-I** | | | | | | | | |
| | | | | | | | | |
| Students Going for Industrial Project / Thesis will complete these courses through MOOCS. Students can also choose SWAYAM or NPTEL with a 12 weeks' course duration in PG level with 3 credits, but the chosen subject should not be covered in their M. Tech Course | | | | | | | | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| | **OE** | **--** | **--** | **--** | **3** | **25** | **75** | **3 Hrs.** |
| | | | | | | | | |
| **OPEN ELECTIVE** | | | | | | | | |
| Students have to choose one open elective course offered by departments other than the parent department.<br>List of open Electives offered by other departments are given below. | | | | | | | | |

| Offered from | Course Code | Course Name | Offered to |
|---|---|---|---|
| CIVIL ENGINEERING | M19 ST 2107 | Construction Management | **CST, CS, PSA,IT & CAD/CAM** |
| | M19 ST 2108 | Green Technology | |
| | M19 ST 2109 | Analysis of Offshore Structures | |
| | | | |
| COMPUTER SCIENCE & ENGINEERING | M19 CST 2106 | Python Programming | **ST, CS, PSA & CAD/CAM** |
| | M19 CST 2107 | Artificial Intelligence | |
| | M19 CST 2108 | Advanced Data structures | |
| | | | |
| ELECTRONICS & COMMUNICATION ENGINEERING | M19 CS 2107 | Signals and systems | **ST, CST, PSA, IT & CAD/CAM** |
| | M19 CS 2108 | Principles of Communication | |
| | M19 CS 2109 | Image and video Processing | |
| | | | |
| ELECTRICAL & ELECTRONICS ENGINEERING | M19PS2107 | Electric And Hybrid Vehicles | **ST, CST, CS, IT & CAD/CAM** |
| | M19PS2108 | Energy From Waste | |
| | M19PS2109 | Energy Management and Auditing | |
| | | | |
| INFORMATION TECHNOLOGY | M19IT2108 | Web Technologies | **ST, CS, PSA & CAD/CAM** |
| | M19IT2109 | Internet of Things | |
| | M19IT2110 | Machine Learning | |
| | | | |
| SCIENCE & HUMANITIES | M19BS2101 | Management and Organisational Behaviour | **ST, CST, CS, PSA, IT & CAD/CAM** |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD2105** | **PE** | **--** | **--** | **--** | **3** | **25** | **75** | **3 Hrs.** |
| | | | | | | | | |
| **MOOCS-II** | | | | | | | | |
| Students Going for Industrial Project / Thesis will complete these courses through MOOCS. Students can also choose SWAYAM or NPTEL with a 12 weeks' course duration in PG level with 3 credits, but the chosen subject should not be covered in their M. Tech Course | | | | | | | | |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|

| M19CAD2106 | PR | 0 | 0 | 20 | 10 | 50 | 50 | 3 Hrs. |
|---|---|---|---|---|---|---|---|---|

**DISSERTATION PHASE-I/ PROJECT**

The Student has to register for Dissertation-I / Industrial project in III semester. Student has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work for approval. The student can initiate the Project work, only after obtaining the approval from the Project Review Committee (PRC).

Continuous assessment of Dissertation-I during the III-Semester will be monitored by the PRC.

Dissertation-I/ Industrial Project is evaluated for 50 internal marks and 50 external marks.

Internal marks 50 awarded by Project Guide and PRC jointly based on continuous assessment consisting of two seminars based on Dissertation work-I.

External marks 50 awarded by External Examiner, Supervisor and Head of the Department jointly based on a review and Viva voce on Dissertation work-I.

**SCHEME OF INSTRUCTION & EXAMINATION**
(Regulation R19)
**M.TECH (CAD/CAM)**
**DEPARTMENT OF MECHANICAL ENGINEERING**
**(**With effect from **2019-2020**Admitted Batch onwards**)**

**IV-SEMESTER**

| Code No. | Name of the Subject | Credits | Lec-ture Hrs | Tutorial Hrs | Lab Hrs | Contact Hrs/ Week | Internal Marks | External Marks | Total Marks |
|---|---|---|---|---|---|---|---|---|---|
| M19CAD2201 | **Dissertation-II / Industrial Project** | 16 | 0 | 0 | 32 | 32 | -- | 100 | 100 |

| Code | Category | L | T | P | C | I.M | E.M | Exam |
|---|---|---|---|---|---|---|---|---|
| **M19CAD2201** | **PR** | **0** | **0** | **32** | **16** | **--** | **100** | **3 Hrs.** |

**DISSERTATION-II/INDUSTRIAL PROJECT**

The student has to continue his/her work from Dissertation-I / Industrial project to complete Dissertation-II in IV semester.

Continuous assessment of Dissertation-II during IV-Semester will be monitored by the PRC.

**Dissertation-II is evaluated for 100 external marks based on Review and Viva Voce.**

Review and Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work for 100 marks.

If the report of the Viva-Voce is unsatisfactory (ie, < 50 marks), the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva-Voce examination, the candidate has to reregister for the project and complete the project within the stipulated time after taking the approval from the College.