NOTIFICATION

No. 194 /2023 Dated : 23/11/2023

Subject : Implementation of new syllabus of Semester I to IV of the Course M.E. Mechanical Engineering (CAD / CAM) as per CBCS Pattern from the Session 2023-2024 onwards.

It is notified for general information of all concerned that the authorities of the University have accepted to implement the new syllabus of Semester I to IV of the Course **M.E. Mechanical Engineering (CAD / CAM)** as per Choice Based Credit System Pattern from the Session 2023-2024 onwards as mentioned below:

Sd/-
(Dr.T.R.Deshmukh)
Registrar

Syllabus Prescribed For
Two Year Post Graduate Course In Master Of Engineering (Full Time & CBCS))
MECHANICAL ENGINEERING (CAD/ CAM)

SEMESTER I

1 MCC1 COMPUTER AIDED DESIGN

Course Objectives:

1) To study CAD systems for implementing.
2) The purpose of CAD is to optimize and streamline the designer's work flow.
3) To Develop a general understanding of fundamental CAD concepts.
4) To impart the parametric fundamentals to create and manipulate geometric models using curves, surfaces and solids.

Course Outcomes:

1) To underst and CAD systems for implementing
2) To develop confidence for self-education and creativity knowledge in their field of Engineering.
3) To understanding of impact of engineering solutions on the society and also will be aware of contemporary issues.
4) To apply geometric transformations on the created wire frame, surface and solid model.

SECTION-A

Unit-I: Introduction: Introduction to computer technology, Introduction to CAD systems, Computer Aided Design work station and peripherals, Graphics input / output devices.

Unit-II: Design process and CAD models: Computers for design, benefits of CAD.
Transformations: 2D and 3D transformations.

Unit-III: ICG: Configuration of graphic work stations, Vector and Raster displays, Geometric modeling and transformations. **CAD/CAM Data Exchange Formats:** Types of file formats &theirexchange, Graphic sstandards. Graphics standards like GKS,PHIGS,IGES etc

SECTION-B

Unit-IV: CAD software: Graphics system and functions of a graphics package, Graphics database sstructure and handling, Operating features, wireframe, solid and surface modeling, approaches to solidmodeling.

Unit-V:Computer aided drafting and documentation: Principles and concepts of automated drafting, drafting packages, Introduction to CAD D packages like Auto CAD, SOLID WORKS, CATIA.

Unit-VI: Curves and Surfaces: Analytical, Synthetic curves with advantages, Dis-advantages, Comparison with parametric curves, Geometric modeling curves and surfaces, Representation, Wire frame models, Parametric representations, Parametric curves and surfaces, Manipulations of curves and surfaces, DDA, Bresenham's / Mid-pointline, circle, ellipse algorithms.

BooksRecommended:

1) CAD/CAM by Groover and Zimmers.
2) Computer Aided Design in Mechanical Engineering by V.Ramamurti
3) CAD by Krishnamoorthy and Rajiv
4) CAD Principles and Applications by Barr, Krimger and Lazaer
5) CAD/CAM Hand-book by Teicholz

1MCC2 COMPUTER AIDED MANUFACTURING

Course Objectives:

1) To develop programming and operating skills for computer numerical control (CNC) machines.
2) To create tool path and program for 2-D Lathe operations.
3) To study methods used in additive manufacturing.
4) To understand the industrial applications of Computer integrated manufacturing.

Course Outcomes:

1) To create2-D tool path and program for 2-D facing, turning, drilling in lathe.
2) Generation of part programs for industrial components using CAM techniques.
3) To analyze the use of CIM for the various industrial applications.
4) Explain the basic concepts of CNC programming and machining.

SECTION-A

Unit-I: Introduction: Need of NC technology, Fundamental concepts in numeric control: structure and functions of NC System, advantages of NC technology over conventional manufacturing.

Unit-II: NC Part Programming: Work holding and tool setting procedure for NC turning and milling centers, Tool zero presetting, Block formats and introduction to ISO based G & M codes forNC part programming, Concepts of tool length and radius compensation, Standard canned cycles used in CNC turning and milling centers, Introduction to automatic NC part program generation from CAD models using standard CAD/CAM software for machining of surfaces, molds and dies etc.

Unit-III: Computer Numerical Control CNC: Problems in conventional NC, NC controller technology, computer numerical control, designing CNC systems. NC/CNC machine tools: Types and features, DDA integrator, DDA hardware interpolator, software interpolators, reference word interpolator, point to point, straight tline and contouring control loops.

SECTION-B

Unit-IV: Application of Computer Integrated Manufacturing (CIM) Systems: Concept and terminology, Part family formation, Classification and coding systems for components, Group technology machine cells. Group technology applications for computer integrated manufacturing, Computer-aided Tooling Design for Manufacturing Processes- Industrial Application.

Unit-V: DNC/CNC systems: Introduction, computer-aided part programming (APT), CNC part programming Direct numerical control (DNC), Types of DNC Systems. Combined DNC / CNC systems.

Unit-VI: Adaptive control: ACC and ACO systems, optimization of AC**. System Devices:** Drives, Feedback devices, Interpolator systems, Control loop circuit elements in point-to-point (PTP) and contouring system, Interpolation schemes for linear and circular interpolations.

Books Recommended:

1) YoramKoren- "Computer control of manufacturing", Mc-Graw Hill.
2) Mikell P.Groover- CAD/CAM- Prentice-Hall of India pvt. Ltd.
3) Kundar T.K. Rao P.N.,Tewari N.K.-Numerical control and computer aided manufacturing; Tata Mc-Graw Hill.
4) D.Kochan-" CAM Develop mention computer integrated Manufacturing, "Springer Verlag, Berlin
5) Groover,M.P.andZimmers,E.W., CAD/CAM: Computer Aided Design & Manufacturing, 2006, Pearson Education India
6) Introduction to Computer Integrated Manufacturing by A.K.Pradhan, M.Elangovan, C.K. Dixit & D.V. Astonkar, AGPH Books, India.
7) Groover, M.P., "Automation, Production systems and Computer Integrated Manufacturing", Pearson Education Asia (2009).

1MMC3 Programme Elective-I (i) ADVANCED MACHINE DESIGN

Course Objectives:

1. To study failure theories and fatigue of materials
2. To study Stress-Life, Strain-Life and LEFM Approach
3. To study Fatigue from Variable Amplitude Loading
4. To study statistical aspects of fatigue of materials
5. To study surface failure in materials

Course Outcomes:

1. Apply failure theories to ductile and brittle materials
2. Apply Stress-Life approach
3. Apply Strain-Life approach
4. Apply LEFM approach
5. Apply fatigue from variable amplitude loading and statistical aspects
6. Apply surface failure approach in mechanical design

SECTION-A

Unit-I: **Introduction:** Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples.

Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, Fatigue design models, Fatigue design methods, Fatigue design criteria, Fatigue testing, Test methods and standard test specimens, Fatigue fracture surfaces and macroscopic features, Fatigue mechanisms and microscopic features.

Unit-II: **Stess-Life (S-N) Approach:** S- N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach.

Unit-III: Strain-Life(-N)approach: Monotonic stress-strain behavior ,Strain controlled test methods ,Cyclic stress-strain behavior, Strain based approach to life estimation, Determination of strain life fatigue properties, Mean stress effects, Effect of surface finish, Life estimation by N approach.

SECTION-B

Unit-IV: LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation.

Unit-V: Statistical Aspects of Fatigue: Definitions and quantification of data scatter, Probability distributions, Tolerance limits, Regression analysis of fatigue data, Reliability analysis, Problems using the Weibull distribution.

Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach.

Unit-VI: Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength.

Books Recommended:

Text Books:

1. Robert L. Norton, Pearson: "Machine Design"
2. S. Suresh: "Fatigue of Materials" - Press, Cambridge, U.K.

Reference Books:

1. Jack. A. Collins, John Wiley, Newyork: "Failure of Materials in Mechanical Design"- 1992.
2. Julie. A. Benantine: "Fundamentals of Metal Fatigue Analysis"- Prentice Hall,1990
3. ASM Hand Book: "Fatigue and Fracture"- Vol. 19, 2002.
4. Ralph I. Stephens, Ali Fatemi, Robert .R. Stephens, Henry Fuchs, John: "Metal Fatigue in Engineering"- Wiley New York, Second edition. 2001.

1MCC3 Programme Elective - I (ii) MECHATRONICS

Course Objectives:

1) To study various types of switches, sensors, motors & their working.
2) To understand the concepts of computer process controls
3) To study various parts of mechatronics.
4) Understand key elements of Mechatronics system, representation into block diagram

Course Outcomes:

1) Time and Frequency domain analysis of system model (for control application)
2) Identification of key elements of mechatronics system & its representation in terms of block diagram
3) Create Pneumatics & Hydraulics system for various industrial applications

SECTION-A

Unit-I: Introduction to Mechatronics – Definition, Block diagram & Example, Basics of Sensors, Position & Speed Sensors, Proximity Sensors & Switches, LVDT, Digital optical encoder, Temperature Sensors Actuators-Functions, Electro-magnetic Principles, Solenoids and Relays, working of DC motors and stepper motors, hydraulic and pneumatic actuators.

Unit-II: Data Acquisition: Analog signal processing using operational amplifier Introduction, types of amplifiers, sample and hold circuit, introduction to data acquisition, sampling thermo, Quantizing theory, Analog to digital conversion, Analog to digital convertor, Digital to analog conversion, Multiplexer.

Unit-III: Mechatronic Systems–control architecture Introduction, Control architecture, Analog circuits, digital circuits, Design of logic networks, sequential logic, flip-flops ,application of flip-flops, micro-controllers, Programmable logic controller.

SECTION-B

Unit-IV: Control Valves–Study of different control components and pneumatic & Hydraulic system Construction, working and function of Directional control valve, Flow control valves, Pressure relief valve, pressure reducing valve, sequence valve with symbols.

Unit-V: Pneumatic System – Design and analysis of pneumatic circuits, Synchronizing, Power chucking operations, controlling the rate of speed of piston, circuit to move with piece around a corner, circuit to move a work piece at a constant speed.

Unit-VI: Hydraulic System – Design analysis of Hydraulic systems - Sequencing, Pneumo-hydraulic, regeneration circuit, circuit to control tool movement on lathers, grinders, etc.

BooksRecommended:

1) "Mechatronics" by HMT.
2) "Introduction to Mechatronics and Measurment Systems", by Michal B. Hist and & David G. Aiciatore.
3) "Industrial Automation", by Turgam,Mir Publication.
4) "Pneumatics and Hydraulics", by Stewart.
5) "Introduction to Mechatronics", by Appus Kuttan K.K.-Oxford University Press.
6) "Mechatronics– A multidisciplinary approach," 4/e by W.Bolton - Pearson Publication,
7) "Automation, Production systems and CIM", by M.PGroover – Pearson Publication.

1MCC3 Programme Elective-I (iii) MANAGEMENT INFORMATION SYSTEMS

Course Objectives:

1) To understand the basic principles and working of information technology.
2) Describe the role of information technology and information systems in business.
3) To contrast and compare how internet and other information technologies support business processes.
4) To give an overall perspective of the importance of application of internet technologies in business administration.

Course Outcomes:

1) Understand and apply the fundamental concepts of information systems.
2) Develop the knowledge about management of information systems.
3) Interpret and recommend the use information technology to solve business problems.
4) Apply a framework and process for aligning organization's IT objectives with business strategy.

SECTION-A

Unit-I: Information systems in Global Business Today: The role of information systems in business today, Perspectives on information systems, Contemporary approaches to information systems, Hands-on MIS projects. Global E-Business and Collaboration: Business process and information systems, Types of business information systems, Systems for collaboration and team work, The information systems function in business. A Case study on E- business.

Unit-II: Information Systems, Organizations and Strategy: Organizations and information systems, How information systems impact organization and business firms, Using information systems to gain competitive advantage, management issues, Ethical and Social issues in Information Systems: Understanding ethical and Social issues related to Information Systems, Ethics in an information society, The moral dimensions of information society. A Case study on business planning.

Unit-III: IT Infrastructure and Emerging Technologies: IT infrastructure, Infrastructure components, Contemporary hardware platform trends, Contemporary software platform trends, Management issues. Securing Information Systems: System vulnerability and abuse, Business value of security and control, establishing frame-work for security and control, Technology and tools for protecting information resources. A case study on cyber crime.

SECTION-B

Unit-IV: Achieving Operational Excellence and Customer Intimacy: Enterprise systems, Supply chain management (SCM) systems, Customer relationship management (CRM) systems, Enterprise application.

Unit-V: Managing Knowledge: The knowledge management landscape, Enterprise wide knowledge management system, Knowledge work systems, Intelligent techniques. Enhancing Decision Making: Decision making and information systems, Business intelligence in the enterprise. Business intelligence constituencies. Building Information Systems: Systems asplannedorganizational change, Overview ofsystems development.

Unit-VI: E-commerce: Digital Markets Digital Goods: E-commerce and the internet, E-commerce-business and technology, the mobile digital platform and mobile E-commerce, Building and E-commerce web site. A Case study on ERP.

Books Recommended:

1) Kenneth C. Laudon and Jane P. Laudon: Management Information System, Managing the Digital Firm, Pearson Education,14th Global edition, 2016, ISBN:9781292094007.
2) James A. O' Brien, George M. Marakas: Management Information Systems, Global Mc-Graw Hill, 10th Edition, 2011, ISBN:978-0072823110.
3) Steven Alter: Information Systems The Foundation of E-Business, Pearson Education, 4th Edition, 2002, ISBN:978-0130617736.
4) W.S. Jawadekar: Management Information Systems, Tata McGraw Hill, 2006, ISBN: 9780070616349.

1MMC4 Programme Elective-II (i) FLEXIBLE MANUFACTURING SYSTEM

Course Objectives:

1. To acquire knowledge concept of flexible manufacturing system
2. To apply the knowledge of group technology and FMS for the automation of industrial processes.
3. To aware different FMS layouts
4. To learn about automated material handling system in industries
5. To design and analyze various FMS.

Course Outcomes (COs):

1. Apply the concepts of PPC and GT to the development of FMS.
2. Develop Plan for Implementation of FMS
3. Be able to discuss the planning and scheduling methods used in manufacturing systems.
4. Identify various workstations, system support equipment.
5. Be able to identify hardware and software components of FMS.
6. Summarize the concepts of modern manufacturing such as JIT, supply chain management and lean manufacturing etc.

SECTION – A

Unit I: FMS an overview: types and configuration, concept, types of flexibility and performance measures, functions of FMS, FMS host and area controller function distribution.

Unit II: Development and implementation of FMS: Planning phases, integration, system configuration for FMS.

Unit III: FMS layout, FMS project, Steps in development of FMS

SECTION – B

Unit IV: Automated material handling and storage: Functions- types- analysis of material handling equipments design on conveyors and AGV systems.

Unit V: Automated Storages: Storage system performance- AS/RS- carausal storage system- WIP storage system- interfacing handling, storage with manufacturing.

Unit VI: Modeling and Analysis of FMS: Analytical, heuristic, queuing, simulation and pertinent modeling techniques- scope, applicability and limitations.

Books Recommended:

1) Groover M.P.- Automation, Production Systems and CIM.
2) Ranky P.G.- The Design and Operation of FMS.
3) Parrish D.J.- Flexible Manufacturing
4) Jha N.K "Handbook of Flexible Manufacturing Systems", Academic Press Inc., 2006.
5) Raouf A. and Ben-Daya M, Editors, "Flexible Manufacturing Systems: Recent Development", Elsevier Science, 2000.

1MMC4 Programme Elective-II (ii) INDUSTRIAL ROBOTICS

Course Objectives:

1. To understand the Robot's anatomy, Robot Configurations and End Effectors.
2. To understand various robot drives, robot motion control and its levels.
3. To study principle of working and applications of different types of robot sensors.
4. To study various methods of teaching and programming the robots.
5. To understand different applications of robots in manufacturing and to understand importance of robot features for a particular application.

Course outcomes:

1. Illustrate the concept of robotics, robot anatomy and various configurations for different industrial application
2. Illustrate drives, controls and sensors used in industrial applications.
3. Identify a particular type of robot depending on its application in manufacturing.
4. Illustrate programming methods for industrial robot.

SECTION – A

Unit I : Fundamentals of Robotics- Introduction, Automation & Robotics- robot applications robotic systems, robot anatomy and robot configurations, Joint types used in robots, robot wrists, joint notation schemes, work value for various robot anatomies, robot Specifications.

Unit II : Robots end-effectors-classification of end-effectors, mechanical grippers, hooking or Lifting grippers, grippers for molten metal , plastics, vacuum cups, magnetic grippers Electrostatic grippers, multiple grippers, internal & external grippers, drive systems for gripers, active & passive grippers. Design consideration in gripper, gripper analysis.

Unit III: Robot drives & Sensors - pneumatic power drives, hydraulic systems, electric drives, Contact type sensors:- wrist force sensor, binary & analog touch sensor, Artificial skins, force, torque, encoders, position, velocity sensors, Non contact type sensors;- vision sensor, proximity, range sensors, safety measures in robot.

SECTION – B

Unit IV: Manipulator Kinematics- Forward & reverse kinematics, forward and reverse transformation of two DOF & three DOF 2-D manipulator, homogeneous transformations, Deviations and problems. Robot dynamics.

Unit V: Robot Control Systems and Programming : Basics of control Systems – Open loop and Closed loop system – robot controllers-servo and non servo systems, motion control of robots, point to point and continuous path control, Process Control Systems, Discrete Control System, Continuous Versus Discrete Control. Linear and Non-linear controls. Teach pendant programming, Lead through programming, Robot programming languages, Robot programming as a path in space, Motion interpolation, Robot Languages: Textual robot Languages, Generation.

Unit VI : Applications of Robot: Robot Application – Implementation of robots in industries – Various steps, Machine loading/unloading. Processing operation, Assembly and Inspection, Feature Application. Types of locomotion, Hopping robots, Legged robots, Wheeled robots, Wall climbing robots, COBOTS, Sensors for mobile robots like global positioning system (GPS), Path planning algorithms, Stochastic dynamic programming (SDP).

Books Recommended:

1. Deb S.R, "Robotics Technology and flexible automation", Tata McGraw-Hill Education, 2nd Edition 2017.
2. Mikell P Groover& Nicholas G Odrey, Mitchel Weiss, Roger N Nagel, Ashish Dutta, Industrial Robotics, "Technology Programming and Applications", McGraw Hill, 2012.
3. Richard D. Klafter, Thomas A, Chri Elewski, Michael Negin, "Robotics Engineering an Integrated Approach", Phi Learning., 2009.
4. Saeed B Niku, "Introduction to Robotics Analysis, Control and Application" Wiley student 2nd Edition,

1MCC4 Programme Elective - II(iii) VIRTUALMANUFACTURING

Course Objectives:

1) An understanding of basic principles, techniques and issues underlying geometric design, digital geometry processing, and the latest virtual prototyping and e-manufacturing solutions in design and manufacturing;
2) A practical awareness of skills required to use virtual prototyping and e-manufacturing solutions to analyze various design and manufacturing activities

Course Outcomes:

1) Describe the principles of and facilities for virtual reality and its applications in digital mock up and virtual manufacturing.
2) Describe the methods and algorithms for collaborative design and design a product assembly by utilizing appropriate collaborative design tools.
3) Demonstrate the applications of VM in material processing through simulation

SECTION-A

Unit-I: Introduction Virtual manufacturing: Definitions, scope of Virtual Manufacturing, Methods and tools used in Virtual manufacturing, Paradigms of VM: Design - centered VM, Production – centered VM and Control-centered VM. Generic VM Issues- relationships between VM, Virtual Prototyping, the Virtual Enterprise. Role of object oriented technology in VM.

Unit-II: Product data visualization: Graphics fundamentals, graphics data representation, polygonal based operations, LOD management, lighting and coloring, illumination and shading. Virtual reality and its applications: computer animation, viewing in 3D, input / output devices, virtual and augmented reality, virtual design, virtual prototyping and virtual manufacturing

Unit-III: Digital Mock-up Unit (DM) in Virtual Manufacturing: Integrated Product and Process Development in Collaborative Virtual Engineering Environment using CATIA Software. Success Factors for Digital Mock-ups (DMU) in complex Aerospace Product Development.

SECTION-B

Unit-IV: Manufacturing process simulation: Factory level, Machine level, Component level, Process level. Integrated Simulation Method to Support Virtual Factory Engineering. Application of Virtual Reality Simulation of a Mechanical Assembly Production Line. Case studies using CATIA, SOLID CAST, PROCAST, OPTICAST simulation software.

Unit-V: Dispersed Network Manufacturing: Virtual factory, enterprise collaborative modeling system, virtual manufacturing (VM) system, Web-based work flow management, collaborative product commerce, applications of multi-agent technology, e-supply chain management and tele-manufacturing.

Unit-VI: Virtual Machining Simulation: STEP-NC based machining simulation . Advanced process simulation and NC program optimization software-simulate real-world performance of machining operations.

Books Recommended:

1) Milan Gregor and Stefan Medvecky (2010), Digital Factory – Theory and Practice, Engineering the Future, Laszlo Dudas (Ed.), ISBN:978-953-307-210-4.
2) An Introduction to CATIA V6 Release (2012): A Hands-on Tutorial Approach-Publisher: Schroff Development Corp (21September, 2011), ISBN-13:978-1585036639.
3) Considine D.M.and Considine G.D. –Standard Handbook of Industrial Automation.
4) Kusiak A.- Intelligent Manufacturing Systems.
5) Fundamentals of Industrial Automation by Turgan.

1MCC5 RESEARCH METHODOLOGY AND IPR

Course Objectives:

1) To give an overview of the research methodology and explain the technique of defining a research problem
2) To explain the functions of the literature review in research.
3) To explain carrying out a literature search, its review, developing theoretical and conceptual frame-works and writing a review.
4) To explain various research designs and their characteristics.

Course Outcomes:

1) Knowledge gained: Understanding of ethical issues related to Research and Publication. Patents and rights. IPR –Intellectual Property Rights.
2) Skills gained: Decision making on research opics. Identifying sources of research problems. Collecting and analyzing data.

SECTION-A

Unit-I: Research Methodology: Introduction, Meaning of Research, Objectives of Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration.

Unit-II: Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, Review of the literature, searching theexisting literature, reviewing the selected literature, Developing a theoretical frame-work, Developing a conceptual frame-work, Writing about the literature reviewed. **Research Design:** Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs.

Unit-III: Design of Sample Surveys: Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs. **Measurement and Scaling:** Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement, Techniques of Developing Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multi-dimensional Scaling, Deciding the Scale. **Data Collection:** Introduction, Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method.

SECTION-B

Unit-IV: Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion,Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis.

Unit-V: Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Unit-VI: Intellectual Property: The Concept, Intellectual Property System In India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act,1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copy right Act,1957,The Protection of Plant Varieties and Farmers' Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992, Competing Rationales for Protection of IPRs, Leading International Instruments Concerning IPR, World Intellectual Property Organization (WIPO),WIPO and WTO, ParisConvention for the Protection of Industrial Property, National Treatment, Right of Priority,Common Rules, Patents, Marks, Industrial Designs, Trade Names, Indications of Source, Unfair Competition, Patent Cooperation Treaty (PCT), Advantages of PCT Filing, Berne Convention for the Protection of Literary and Artistic Works, Basic Principles, Duration of Protection, Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreement, Covered under TRIPS Agreement, Features of the Agreement, Protection of Intellectual Property under TRIPS, Copyright and Related Rights, Trademarks, Geographical indications, Industrial Designs, Patents, Patentable Subject Matter, Rights Conferred, Exceptions, Term of protection, Conditions on Patent Applicants, Process Patents, Other Use without Authorization of the Right Holder, Layout-Designs of Integrated Circuits, Protection of Un disclosed Information, Enforcement of Intellectual Property Rights, UNSECO.

Books Recommended:

1) Research Methodology: Methods and Techniques C.R. Kothari, Gaurav Garg NewAgeInternational 4th Edition, 2018
2) Research Methodology a step-by step guide for beginners. (For the topic Reviewing the literature under module 2) Ranjit Kumar SAGE Publications Ltd. 3rd Edition, 2011.
3) Study Material (For the topic Intellectual Property under module 5) Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September 2013.

1MCC6 LAB-I (COMPUTER AIDED DESIGN)

Course Objectives:

1) Introduction to CAD and its role in the industry.
2) Study of algorithms for displaying line.
3) To simulate geometric transformation.

Course Outcomes:

1) To understand & utilize applications of CAD Software.
2) Create solid models of components using the advanced solid modeling tools.
3) Assemble the solid components using the assembly modeling tools and prepare the product drawing / drafting.

List of Practical's:

At least six (6) practical's of the following list of practicals:

1) To study line generating digital different analyzer (DDA) algorithm.
2) To study Bresenhum's circuit algorithm.
3) To study geometric transformation.
4) Prepare 2D drawing using Auto CAD.
5) Study of graphic package for computer aided drafting CATIA / Creo and also draw spurgear using CATIA/Creo.
6) Generate 3-D model sketch using CATIA / Creo CAD software
7) Introduction to reverse engineering and its scope in CAD
8) To explore the applications of CAD in different areas of engineering.

1MCC7 LAB-II COMPUTER AIDED MANUFACTURING

Course Objectives:

1) Introduction to CAM and its role in the industry
2) To study different parts of CNC machine tools in general.

Course Outcomes:

1) To understand & utilize applications of CAM in Industry.
2) Modeling of simple machine parts and assemblies from the part drawings using standard CAD packages.

Listof Practical's:

At least six practical's of the following list of practicals:

1) To study of part programming
2) To study G71 turning cycle
3) To study G72 turning cycle
4) To study G83 & G84 pack drilling & right pack ratting cycle.
5) G12 circular pocket milling CW G13 circular pocket milling CCW.
6) Thread milling with helical motion.
7) Construction and Working of NC/CNC Machine Tools
8) To study the various emerging technologies in CIM environment, its application and scope.

1MCC8 / 2MCC8 AUDIT COURSE - I*

1MCC8 / 2MCC8
AUDIT 1 and 2: (i) ENGLISH FOR RESEARCH PAPER WRITING

Course Objectives: Students will be able to:
1. Demonstrate writing meaningful sentences and coherent paragraphs
2. Show conciseness, clarity and avoid redundancy in writing
3. Summarize, evaluate literature, and write methodology, results and conclusion
4. Describe how to develop title, write abstract and introduction
5. Apply correct style of referencing and use punctuation appropriately

Course Outcomes:
1. Explain planning and preparation required for research communication
2. Use appropriate word order and write short sentences, writing coherent paragraphs and sentences
3. Demonstrate conciseness, clarity and avoid redundancy
4. Write abstract, introduction, summarize, evaluate literature, methodology, discussions, results and conclusion
5. Use correct punctuation, correct style(s) of in-text citation and bibliography and avoid plagiarism

SECTION-A

Unit I: Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

Unit II: Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction.

Unit III: Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

SECTION-B

Unit IV: 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 V: 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 VI: Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

Books Recommended:

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
3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook .
4. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011.

AUDIT 1 and 2: (ii) DISASTER MANAGEMENT

Course Objectives:

1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarianresponse.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Course Outcomes:

1. Knowledge of disaster and its types.
2. Knowledge of Repercussions of Disasters And Hazards.
3. Study of Seismic Zones and Disaster Prone Areas In India.
4. Study of Disaster Preparedness and Management.
5. Understanding Disaster Risk Situation, Risk Assessment and Disaster Mitigation in India.

SECTION-A

Unit I: **Introduction Disaster:** definition, factors and significance; difference between hazard and disaster; natural and manmade disasters: difference, nature, types and magnitude.

Unit II: **Repercussions Of Disasters And Hazards**: economic damage, loss of human and animal life, destruction of ecosystem. natural disasters: earthquakes, volcanisms, cyclones, tsunamis, floods, droughts and famines, landslides and avalanches, man-made disaster: nuclear reactor meltdown, industrial accidents, oil slicks and spills, outbreaks of disease and epidemics, war and conflicts.

Unit III: Disaster Prone Areas In India study of seismic zones; areas prone to floods and droughts, landslides and avalanches; areas prone to cyclonic and coastal hazards with special reference to tsunami; post-disaster diseases and epidemics

SECTION-B

Unit IV: Disaster Preparedness and Management Preparedness: monitoring of phenomena triggering a disaster or hazard; evaluation of risk: application of remote sensing, data from meteorological and other agencies, media reports: governmental and community preparedness.

Unit V: Risk Assessment Disaster Risk: concept and elements, disaster risk reduction, global and national disaster risk situation. techniques of risk assessment, global co-operation in risk assessment and warning, people's participation in risk assessment. strategies for survival.

Unit VI: Disaster Mitigation: meaning, concept and strategies of disaster mitigation, emerging trends in mitigation. structural mitigation and non-structural mitigation, programs of disaster mitigation in india

Books Recommended:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company.
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L.,Disaster Administration And Management Text And Case Studies" ,Deep &DeepPublication Pvt. Ltd., New Delhi.

AUDIT 1 and 2: (iii) 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:

1. Knowledge of History and Philosophy of the Indian Constitution.
2. Understanding the Contours of Constitutional Rights & Duties.
3. Study of Organs of Governance.
4. Understanding the Local Administration.
5. Study of Election Commission.

SECTION-A

Unit I: **History of Making of the Indian Constitution:** History Drafting Committee, (Composition & Working)

Unit II: **Philosophy of the Indian Constitution:** Preamble, Salient Features

Unit III: **Contours of Constitutional Rights and Duties:** Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

SECTION-B

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

Unit V: **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: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Unit VI: **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.

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

AUDIT 1 and 2: (iv) STRESS MANAGEMENT BY YOGA

Course Objectives: Students will be able to:
1. To achieve overall health of body and mind
2. To overcome stress

Course Outcomes:
1. Knowledge of Eight parts of yog (Ashtanga).
2. Understanding the Do`s and Don't's in life.
3. Knowledge of Yam and Niyam, Asan and Pranayam.
5. Regularization of breathing techniques and its effects.
6. Develop healthy mind in a healthy body thus improving social health and efficiency.

SECTION-A

Unit I: Definitions of Eight parts of yog. (Ashtanga)
Unit II: Do`s and Don't's in life.
Yam. Ahinsa, satya, astheya, bramhacharya and aparigraha
Unit III: Niyam. Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

SECTION-B

Unit IV: Asan and Pranayam
Unit V: Various yog poses and their benefits for mind & body
Unit VI: Regularization of breathing techniques and its effects-Types of pranayam

Books Recommended:
1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

AUDIT 1 and 2: (v) SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives: Students will be able to:
1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learn Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore huge knowledge from ancient literature

Course Outcomes:
1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science and technology can be understood
3. Being a logical language will help to develop logic in students.

SECTION-A

Unit I: Alphabets in Sanskrit,
Unit I: Past/Present/Future Tense,
Unit III: Simple Sentences

SECTION-B

Unit IV: Concepts in Mathematics, Order, Introduction of roots,
Unit V: Technical information about Sanskrit Literature
Unit VI: Technical concepts of Engineering-Electrical, Mechanical, Architecture

Books Recommended:
1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi.

AUDIT 1 and 2: (vi) VALUE EDUCATION

Course Objectives: Students will be able to:
1. Understand value of education and self- development
2. Imbibe good values in students
3. Let the should know about the importance of character

Course Outcomes:
1.Knowledge of self-development
2.Learn the importance of Human values
3.Developing the overall personality.

SECTION-A

Unit I: Values and self-development, Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non- moral valuation, Standards and principles, Value judgments
Unit II: Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration. Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline
Unit III: Personality and Behavior Development, Soul and Scientific attitude, Positive Thinking, Integrity and discipline, Punctuality, Love and Kindness. Avoid fault Thinking, Free from anger, Dignity of labour.

SECTION-B

Unit IV: Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature

Unit V: Character and Competence, Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women.
Unit VI: All religions and same message. Mind your Mind, Self-control. Honesty, studying effectively

Book Recommended:
1. Chakroborty, S.K. "Values and Ethics for organizations Theory and practice", Oxford Univ. Press, New Delhi.

AUDIT 1 and 2: (vii) PEDAGOGY STUDIES

Course Objectives: Students will be able to:
1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2. Identify critical evidence gaps to guide the development.

Course Outcomes:
1. Knowledge of Theories of learning and Conceptual framework.
2. Understanding the Pedagogical practices.
3. Theory of change when pedagogical practices are done.
4. Understanding the Professional development and Barriers to learning.
5. Study of Research gaps and future directions.

SECTION-A

Unit I: **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: Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries. Curriculum, Teacher education.
Unit III: 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?

SECTION-B

Unit IV: 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.

Unit V: Professional development: alignment with classroom practices and follow up support, Peer support, Support from the head teacher and the community. Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

Unit VI: Research gaps and future directions,Research design, Contexts,Pedagogy, Teacher education, Curriculum and assessment, Dissemination, and research impact.

Books Recommended:

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 basic maths and reading in Africa: Does teacher preparation count? International Journal 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.

AUDIT I and II: (viii) PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Objectives: Students will be able to:
1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Course Outcomes:
1. Knowledge of Holistic development of personality (Neetisatakam)
2. Approach to day to day work and duties.
3. Understanding the personality of role model will lead the nation and mankind to peace and prosperity
4. Study of Personality Development through life enlightenment skills and achieve the highest goal in life.

SECTION-A

Unit I: Neetisatakam-Holistic development of personality
Verses- 19,20,21,22 (wisdom)
Verses- 29,31,32 (pride & heroism)

Unit II: Neetisatakam-Holistic development of personality
Verses- 26,28,63,65 (virtue)
Verses- 52,53,59 (dont's)
Verses- 71,73,75,78 (do's)

Unit III: Approach to day-to-day work and duties.
Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48,

SECTION-B

Unit IV: Approach to day-to-day work and duties.
Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35,
Chapter 18-Verses 45, 46, 48.

Unit V: Statements of basic knowledge.
Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68
Chapter 12 -Verses 13, 14, 15, 16,17, 18

Unit VI: Personality of Role model. Shrimad BhagwadGeeta:
Chapter2-Verses 17, Chapter 3-Verses 36,37,42,
Chapter 4-Verses 18, 38,39
Chapter18 – Verses 37,38,63

Books Recommended:

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

***Examination and evaluation for Audit I & II shall be conducted at Institute level.**

SEMESTER –II

2MCC1 FINITE ELEMENT ANALYSIS

Course Objectives:

1. To introduce the concepts of Mathematical Modeling of Engineering Problems
2. To appreciate the use of FEM to a range of Engineering Problems
3. To understand the philosophy and general procedure of Finite Element Method as applied to solid mechanics and thermal analysis problems.
4. To familiarize students with the displacement-based finite element method for displacement and stress analysis and to introduce related analytical and computer tools.
5. It provides a bridge between hand calculations based on mechanics of materials and machine design and numerical solutions for more complex geometries and loading states

Course Outcomes:

1. Upon completion of this course, the students can able to understand different mathematical Techniques used in FEM analysis
2. Understand the concepts of Nodes and elements
3. Understand use of FEA in Structural and thermal problem
4. Understand the application of FEA in heat transfer problem
5. Learn how to do analysis learn the various concepts and types of analysis
6. Learn finite element modeling techniques.

SECTION-A

Unit-I: Introduction: Discretization, going from part to whole approach, Conventional Numerical methods- finite difference method , method of least squares Ritz method, boundary value problems, displacement method, the equilibrium method, the mix method of solid mechanics, Finite element formulation, variational methods

Unit-II: Finite Elements- types: triangular, rectangular, quadrilateral, sector curved, Concept of isoparametric elements, Terms Isoparametric, super parametric and sub-parametric. Iso-parmetric formulation of bar element

Unit-III:. General procedure of FEM: Discretization, element shapes, interpolation functions, shape functions, element stiffness matrix, global stiffness matrix, application of boundary conditions, solutions

SECTION-B

Unit-IV: FEA of 2-D single variable problems, application of Heat transfer, fluid mechanics, solid mechanisms, plane elasticity, analysis of structural vibrations

Unit-V: Applications: Free vibration of thin plates, cylindrical shells, transient heat conduction, torsion of prismatic shafts, motion of fluid in flexible container, flow of ideal fluids, viscous fluids, sheep structures

Unit-VI: Software's in FEM: Introduction and study of FEM packages like ASKA, SAP, NASTRAN, ANSYS, COSMOS, NISA, and ANIDA

Practical: Five practical based on above syllabus.

References:

1) Introduction to Finite Element Methods by C.S. Desai & J.F. Abel.
2) Concept and application of Finite element analysis by Robert Cook.
3) Finite element analysis by C.S. Krishnamoorthy.
4) Finite element methods by J.N. Reddy.

2MCC2 SIMULATION THEORY AND APPLICATIONS

Course Learning Objective:

1. Define the basics of simulation modeling and replicating the practical situations in organizations
2. Generate random numbers and random variates using different techniques.
3. Develop simulation model using heuristic methods.
4. Analysis of Simulation models using input analyzer, and output analyzer
5. Explain Verification and Validation of simulation model

Course Outcomes:

1. Describe the role of important elements of discrete event simulation and modeling paradigm.
2. Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.
3. Develop skills to apply simulation software to construct and execute goal-driven system models.
4. Interpret the model and apply the results to resolve critical issues in a real world environment.

SECTION-A

Unit-I : System models and studies: Concepts of a system, system environment, stochastic activities, continuous and discrete systems, system modeling, types of models, principles used in modeling, subsystems, types of system studies.

Unit-II : System simulation: The techniques of simulation, Monte Carlo method, comparison of simulation and analytical methods, Analog computers and methods, hybrid computer, simulators, continuous system simulation languages.

Unit-III : system dynamics, growth models, logistic curves, multi-segment models, probability concepts in simulation, system simulation, events, representation of time, arrival pattern.

SECTION-B

Unit-IV: Analysis of simulation output: Estimation method, simulation run statistics, replications of runs, elimination of initial bias, batch means.

Unit-V: regenerative techniques, time series analysis, spectral analysis, auto regression.

Unit-VI: Applications of simulation in manufacturing

References:

1) Geoffrey Gordon- System Simulation
2) Narsingh Deo- System Simulation with Digital Computers.
3) Naylor T.H. et. Al.- Computer Simulation Techniques.
4) Gottfried B.S- Elements of Stochastic Process Simulation

2MCC3 Program Elective- III

(i) OPTIMIZATION METHODS IN ENGINEERING DESIGN

Course Objectives:

1. To introduce mathematical theory behind optimization
2. To introduce exact methods for optimizing unconstrained functions
3. To introduce exact methods for optimizing constrained functions
4. To learn basics of different evolutionary algorithms.
5. Techniques to solve various models arising from engineering areas.

Course outcomes:

1. Explain the engineering applications of optimization
2. Use exact methods for optimizing unconstrained functions
3. Use exact methods for optimizing constrained functions
4. Use different novel methods for optimization and algorithms
5. Solve various optimization problems arising from engineering areas.

SECTION – A

Unit I: Introduction: Historical Developments, Engineering applications of Optimization Classical Optimization Techniques: Introduction, Review of single and multivariable optimization methods with and without constraints, Nonlinear one-dimensional minimization problems, Examples.

Unit II: Constrained Optimization Techniques:Introduction, Direct methods - Cutting plane method and Method of Feasible directions, Indirect methods - Convex programming problems, Exterior penalty function method, Examples and problems

Unit III: Unconstrained Optimization Techniques:Introduction, Direct search method - Random, Univariate and Pattern search methods, Rosenbrock's method of rotating coordinates, Descent methods - Steepest Decent methods- Quasi-Newton's and Variable metric method, Examples.

SECTION – B

Unit IV: Geometric Programming: Introduction, Unconstrained minimization problems, solution of unconstrained problem from arithmetic-geometric inequality point of view, constrained minimization problems, generalized polynomial optimization, Applications of geometric problems.

Unit V: Novel methods for Optimization:Introduction to simulated annealing, selection of simulated annealing parameters, simulated annealing algorithm; Genetic Algorithm (GA), Design of GA, Key concepts of GA, Neural Networks, A frame work for Neural Network models, Construction of Neural Network algorithm, Examples of simulated algorithm, genetic annealing and Neural Network method, Fuzzy optimization techniques.

Unit VI: Special topics in Optimization: Integrating simulation in optimization models, Multidisciplinary optimization, FEA optimization, Stochastic optimization, Robustness and tolerance optimization. Use of Matlab to solve optimization problems.

Books Recommended:

Text Books:

1. Engineering Optimization, S. S. Rao New Age International
2. Optimization for Engineering Design, Kalyanmoy Deb Prentice Hall of India
3. Ashok D. Belegundu, Tirupathi R. Chandrupatla, Optimization Concepts and Applications in Engineering, Pearson Education, 1998.

Reference Books:

1. Applied Optimal Design, E. J. Haug and J.S. Arora Wiley, New York
2. Optimization, G.V. Reklaites, A. Ravindran and K.M. Rogsdeth Wiley, New York
3. Ignizio, J. P., 1982, Linear Programming in Single and Multi-Objective Systems, PrenticeHall, Englewood Cliffs, New Jersey.
4. Luenberger, D. G., 1984, Linear and Nonlinear Programming, Addison-Wesley Publishing Company, Inc., Reading, Massachusetts.

2MCC3 Programme Elective- III (ii) ADVANCED MATERIALS TECHNOLOGY

Course Objectives:

1. To learn the various advanced materials used for engineering applications.
2. To learn the effect of strengthening on structure and mechanical properties of materials.
3. To learn behavior of advanced materials under various manufacturing processes.
4. To learn the various modern metals and non metals and their applications.

Course outcomes:

1. Comprehensive understanding of various advanced materials.
2. Understanding the principles and concepts of internal structure of materials.
3. Applying the knowledge of material properties for various applications.
4. Exploring the advanced manufacturing techniques of various metals and non metals.

SECTION – A

Unit I: Materials and Classification: Solid materials- Classification, Ceramics, composites and metal glasses, selection and application of tool steel, Magnetic alloys, Copper, aluminum and magnesium alloys, Bearing alloys, Super hard materials, Plastics, Alloying techniques, Thermal, mechanical and chemical methods, Power metallurgy techniques.

Unit II: Mechanical Properties: Strengthening mechanism of materials, elements of dislocation theories, Strain hardening, Grain size control, Single crystal growth, Reinforcing fibres for polymers, Composite structure, determination of mechanical properties of materials, Dynamic tests, Fracture and toughness tests, Low temperature and high temperature tests, Creep characteristics, Hot hardness tests.

Unit III: Processing of Materials for Casting and Joining: Plastic working of materials, Strain hardening, Recovery and re-crystallization, Formability, Forgibility and drawability of materials, Powder processing of materials, Ceramic processing, Composite processing, Features controlling machinability of materials, thermal treatment for better mach inability of metals, Universal mach inability index.

SECTION – B

Unit IV: Modern Materials and Alloys:Super alloys-refractory materials, Ceramic and their applications, Low melting alloys, Shape memory alloys, Advanced Composites Particulate and dispersion composites, Metal matrix and ceramic matrix composites, Carbon-Carbon composites, Ti and Ni based alloys for gas turbine applications, Managing and cryogenic steels, smart and nano materials.

Unit V: Non metallic materials: Polymeric materials - Formation of polymer structure - Production techniques of fibres, foams, adhesives and coatings - Structure, properties and applications of engineering polymers - Advanced structural ceramics, WC, TiC, TaC, AI2O3, SiC, Si3N4, CBN and diamond – properties and applications.

Unit VI: Composite Materials: Fiber reinforced, laminated and dispersed materials with metallic matrix of aluminium, copper and Titanium alloys and with non-metallic matrix of unsaturated polyesters and epoxy resins. Development, Important properties and applications of these materials. Smart Materials:Varistors and Intelligent materials for bio-medical applications. Nanomaterials: Definition, Types of nanomaterials including carbon nanotubes and nanocomposites, Physical and mechanical properties, Applications of nanomaterials.

Books Recommended:

Text Book:

Engineering Materials and Applications P. Flinn and P.K. Trojan MIR Publications 2. Engineering Materials: Polymers, Ceramics and Composites A.K Bhargava Prentice Hall of India

Reference Books:

1. Manufacturing processes for Engineering Materials SeropeKalpakjian Wesley Publishing Co.
2. An introduction to Physical Metallurgy S.H. Avner McGraw Hill
3. Advances in Materials and Their Applications P. Rama Rao Wiley Eastern
4. Mechanical Metallurgy Dieter McGraw Hill:
5. P.C.Shrma, Production technology
6. Thomas H.Courtney, " Mechanical Behaviour of Materials ", (2nd Edition), McGrawHill,
7. Charles J.A., Crane, F.A.A and Furness, J.A.G., " Selection and use of Engineering Materials", (3rd Edition), Butterworth-Heiremann, 1977.
8. Flinn, R.A. and Trojan, P.K., " Engineering Materials and their Applications ", (4th Edition), Jaico, 1999.
9. George E.Dieter, " Mechanical Metallurgy ", McGraw Hill, 1988.
10. Engineering Material Technology James A. Jacobs & Thomas F. Kilduff Prentice Hall
11. Materials Science and Engineering WD. Callister Jr. Wiley India Pvt. Ltd 2010
12. Engineering Design: A Materials and Processing Approach G.E. Dieter McGraw Hill 1991

13. Materials Selection in Mechanical Design M.F. Ashby Pergamon Press 1992
14. Introduction to Engineering Materials & Manufacturing Processes NIIT Prentice Hall of India
15. Engineering Materials Properties and Selection Kenneth G. Budinski Prentice Hall of India
16. Selection of Engineering Materials Gladius Lewis Prentice-Hall, New Jersey.

2MCC3 Programme Elective- III (iii) ADVANCED MECHANICAL VIBRATIONS

Course Objectives:
1. Understand mathematical techniques necessary for describing and analyzing mechanical vibration
2. To impart the ability to model, analyze and solve vibration problems.
3. To impart the knowledge of vibration control techniques and the ability to apply these techniques.
4. Understand vibration measurement techniques and ability to choose the correct technique in a given situation.
6. To introduce modern vibration data acquisition software and hardware

Course outcomes:

1. Ability to approach real-world vibration problem and describing and analyzing vibrations
2. Make use of analytical and experimental dynamic models of a given situation
3. Ability to acquire and interpret Frequency Response Functions
4. Ability to describe basic vibration data acquisition hardware and excitation techniques
5. Proficiency in data acquisition and analysis software and new functionality and capabilities as needed.

SECTION – A

Unit-I: Introduction: Free and forced vibrations with and without damping, transient vibrations, Laplace transform formulation.

Unit-II: Isolation and Stability Criterion:Vibration isolation and transmissibility, undamped vibration absorbers, self-exited vibrations, criterion of stability, effect of friction on stability.

Unit-III: Nonlinear Vibration: Free vibration with nonlinear spring force or nonlinear damping, phase plane, energy curves, Lienard's graphical construction, methods of isoclines, random vibration, power spectral density, bandwidth in vibration, numerical methods for vibration analysis, vibration of continuous systems, Euler equation for beams, effect of rotary inertia and shear deformation.

SECTION – B

Unit-IV: Vibration Analysis of Rotors **:**Transverse vibrations single, two and three rotor systems, critical speeds of shafts, torsional vibrations of rotors: one, two and three disc rotor system, frequency of torsional vibration systems, coupling of torsional and bending vibrations due to pretwist and eccentricity, rotor faults, forward and backward rotor whirl model, variable elasticity effects in rotating systems, flow induced vibration in rotating systems, Newkirk effect, stresses in rotating disc and blade, disc of uniform strength, thermal stresses.

Unit-V: Vibration Measurement and Application: Variable Resistance Transducers ,Piezoelectric Transducers , Electrodynamic Transducers , Linear Variable Differential Transformer Transducer ,Vibration Pickups , Vibrometer , Accelerometer , Velometer , Phase Distortion , Frequency-Measuring Instruments , Vibration Exciters , Mechanical Exciters , Electrodynamic Shaker , Signal Analysis , Spectrum Analyzers , Bandpass Filter , Constant-Percent Bandwidth and Constant-Bandwidth Analyzers

Unit-VI: Diagnostic Techniques :Introduction to diagnostic maintenance and instrumentation in machinery vibration, amplitude, frequency and phase characteristics, signature analysis-trend plot, time domain plot, frequency domain plot, FFT, spectrum plot, fault detection transducers, artificial intelligence techniques applied to vibration analysis.

Books Recommended:
1. S. S. Rao. Mechanical Vibrations, 4th Edition, Pearson Education, 2007.
2. L. Meirovitch. Fundamentals of Vibrations, McGraw Hill, 1st edition, 2001.
3. E. Krämer. Dynamics of Rotors and Foundations, Springer-Verlag, New York, 1993.
4. R. Subbiah and J. E. Littleton. Rotor and Structural Dynamics of Turbomachinery-A Practical, 1st edition, 2018.
5. P. Luciano Gatti. Advanced Mechanical Vibrations: Physics, Mathematics and Applications. CRC Press; 1st edition 2020.

2MCC4 Programme Elective IV - (i) INDUSTRIAL PRODUCT DESIGN

Course Objectives:

1. Understand modern product development processes.
2. Understand and explain the concept of Industrial design and robust design concepts.
3. Understand the concept of Design for manufacture and assembly.
4. Understand the legal factors, social issues, engineering ethics related to product design.

Course Outcomes:

1. Use the Product Design and Development Process, as a means to manage the development of an idea from concept through to production.
2. Employ research and analysis methodologies as it pertains to the product design process, meaning, and user experience.Apply creative process techniques in synthesizing information, problem-solving and critical thinking.
3. Demonstrate and employ hand drawing and drafting principles to convey concepts.
4. Use basic fabrication methods to build prototype models for hard-goods and soft-goods and packaging.

SECTION-A

Unit-I: An approach to industrial design, Technical requirements, Ergonomic requirements, Aesthetic requirements.

Unit-II : Ergonomic and industrial design Man- Machine relationship, Anthropometric data, Ergonomical design aspects of M/c tools testing M/cs, Instruments, automobile process equipment, etc.

Unit-III: Aesthetic concepts: Concepts of unity, concept of order with variety, concept of purpose, style and environment, Aesthetic continuity, proportions, rhythm, radiance.

SECTION-B

Unit-IV: Design for Producibility, design for Assembly & Disassembly, Design for Maintenance

Unit-V: Computer aided Product Design.

Unit-VI: Industrial Design in Graphics: general design situations, Specifying design requirements, rating the importance of Industrial Design. Design & development for Generative Manufacturing Processes. Product Patenting

References:

1. Industrial Design for Engineers by W.H. Mayali.
2. Design Engineering by John Diwan .
3. Problems of Product Design development by C.Hearn Bucle Pergaman Press.
4. Product Design & Manufacture by John Lindbeck , Prentice Hall International.
5. Integrated Product & Process Design by Edward Magrab, RC Press.

2MCC4 Programme Elective- IV (ii) CONCURRENT ENGINEERING

Course Objectives:

1. Acquire knowledge about entire product life cycle, from design to disposal, in an integrated design process.
2. To introduce Concurrent Engineering Principles applied to manufacturing Sectors.
3. State various techniques and concepts of achieving manufacturing excellence through Concurrent Engineering.
4. Acquire knowledge regarding manufacturing competitiveness, life cycle management, product process, and organization.

Course Outcomes:

1. Understand the need for adopting CE methodology to organizations.
2. Understand the importance of such factors as the right corporate culture, multidisciplinary teams and their empowerment for successful implementation of CE.
3. Undertake an evaluation of the company's present communication infrastructure and recommend suitable changes to support the CE environment.
4. Become familiar with a range of computer based tools for modeling engineering processes and information
5. Understand various factors and techniques required to optimize the product development process.

SECTION-A

Unit I: Introduction **:** Principles, traditional versus concurrent approach, schemes and tools of concurrent engineering, Applications of computers in practice of CE

Unit II: Basic process issues **:** Process models, types, importance, relation between models, specifications, technology, automation and process improvement.

Unit III: Concurrent engineering approach in manufacturing systems**:** System design procedure, features, assembly resource alternatives, tasks assignments

SECTION-B

Unit IV: Concurrent automated fabrication systems**:** Introduction, methodology, preliminary and details work content analysis, human resource considerations, 'Technical Economic' performance evaluation.

Unit V: Assembly work stations: Strategic issues, technical issues, economic analysis.

Unit VI: Case studies of concurrent engineering practice

References:

1. David Bedwarth, M.R. Handerson & Philip Wilze- Computer integrated Design and manufacturing.
2. J.L. Nevines and D.E. Whitney-Concurrent Design of Products and Processes.
3. Procedding of the "Summer school on Application of ConcurrentEngineering to Product Development" at P.S.G.College of Technology

2MCC4 Programme Elective- IV (iii) RAPID PROTOTYPING AND TOOLING

Course Objective:

1. Understand the various steps in product design and development
2. To aware about various methods of Rapid Prototyping processes
3. Understand the various parameters in Rapid Prototyping processes
4. Know the need of Tooling in Rapid Prototyping processes
5. Aware the concept of Reverse Engineering

Course Outcomes:

1. Aware of role of rapid prototyping in product development process
2. To identify various Rapid Prototyping Processes
3. Analyze the principles of Stereo lithography and Laser sintering process
4. Understand various types of Pre-processing, processing, post-processing errors in Rapid prototyping.
5. To Identify the various types of data formats and software's used in Rapid prototyping
6. To understand the concept of Reverse engineering.

SECTION – A

Unit I: Introduction: Need for time compression in product development, Product development conceptual design, Development, Detail design, Prototype, Tooling Applications of RP.

Unit II: Stereo lithography systems: Principle, Process parameters, Process details, Machine details, Applications.

Unit III: Laser sintering systems: Principle, Process parameters, Process details, Machine details, Applications. Fusion deposition modeling: Principle, Process parameters, Process details, Machine details, Applications.

SECTION – B

Unit IV: Laminated object manufacturing: Principle, Process parameters, process details, Machine details, Applications.

Unit V: Laser engineering net shaping (lens): Ballistic Particle Manufacturing (BPM), 3D printing. Principle, Introduction to rapid tooling, Direct and indirect method, Commercial software for RP, STL file generation.

Unit VI: Rapid tooling techniques- vacuum casting, DMLS, etc. Introduction to reverse engineering.

Books Recommended:

1. Pham, D.T. & Dimov.S.S., "Rapid manufacturing", Springer -Verlag, London, 2001.
2. Terry wohlers, "Wohlers Report 2007", Wohlers Associates, USA, 2007.
3. Ghosh A., "Rapid Prototyping: A Brief Introduction", Affiliated East West,
4. Kenneth G. Cooper, "Rapid Prototyping Technology: Selection and Application", CRC Press, 2001.
5. Chua Chee Kai, Leong Kah Fai, Lim Chu -Sing, "Rapid Prototyping: Principles and Applications", World Scientific, 2003.

2MCC5 FINITE ELEMENT ANALYSIS Lab-1

List of Practicals:

1. 1D Static Analysis of Balcony Truss
2. 2D Static Analysis of a Book Shelf Bracket
3. 2D Static Structural Analysis of a Bicycle Spanner
4. 3D Thermal Analysis of Plastic Window
5. 2D Flow Analysis around a Cylinder
6. Transient Analysis of Fin
7. Natural Frequency of Frame.

2MCC6 SIMULATION THEORY AND APPLICATIONS Lab-2

List of Practicals:

1. Study of Simulation and Simulation Packages.
2. Simulation of Inventory problem using random numbers.
3. Simulation of Queuing Problem using Random Numbers.
4. Introduction and Study of Witness Simulation Software "A Flexible Suite of Simulation Tools"
5. Simulation of spring and Mass Damper System Using MATLAB.

2MMC7 SEMINAR

Course Objectives:

1. Identify and compare technical and practical issues related to the area of course specialization.
2. Outline annotated bibliography of research demonstrating scholarly skills.
3. Prepare a well-organized report employing elements of technical writing and critical thinking.
4. Demonstrate the ability to describe, interpret and analyze technical issues and develop competence in presenting.

Course Outcomes:

1. Review, prepare and present on recent technological developments
2. Organize a detailed literature survey and build a document with respect to technical publications.
3. Make use of new and recent technology (e.g. Latex) for to prepare technical report
4. Establish motivation for any topic of interest and develop a thought process for technical presentation.
5. Analysis and comprehension of proof-of-concept and related data.
6. Effective presentation and improve soft skills.

Method of Evaluation:

During the seminar session each student is expected to prepare and present a topic on recent technological developments with respect to technical publications, for duration of about 15 to 20 minutes.
In a session of a period per week, students are expected to present the seminar.
Each student is expected to present at least once during the semester and the student is evaluated based on their performance.
At the end of the semester, He / She will submit a report on His / Her topic of seminar and are awarded based on the report presentation.
Evaluation is 100% Internal.

SEMESTER –III

3MCC1 Program Elective –V (i) DESIGN OF EXPERIMENTS

Course Objectives:

1. To design and conduction of experiments
2. To analyze them properly to answer various research questions.
3. Explain the key concepts of DOE, and why it is used
4. Specify fractional and full factorial designs
5. Specify specialized designs, e.g. Taguchi, Box-Wilson, others
6. Use Excel-based software to design experiments and analyze data

Course outcomes:
By the end of this course, the students will be able to:

1. Develop an understanding of how to identify research topics, formulate research questions and corresponding hypotheses, select an appropriate research and whereapplicable, experimental design
2. Perform required statistical analyses for any univariate application in a business / industrial setting, regardless of data form, and will be familiar with major indices for measuring correlation and association.
3. Understand and review the underlying assumptions related to each statistical test and itsinterpretation.

SECTION-A

Unit I: Randomization: Observational studies and randomized experiments, confounding, practical considerations when performing randomization.

Unit II: Completely randomized designs: t-test, power and sample size calculations, non-normal observations.

Unit III: Factorial designs: factorial structures, main effects and interactions, interaction plots, ANOVA for balanced factorials, general factorial model, hierarchical factorial model, factorial contrasts, power and sample size calculation for factorial models.

SECTION-B

Unit IV: Mixed effects models: models with random effects, ANOVA for random effects, crossed and nested factors, Hasse diagrams.

Unit V: Block designs: randomized complete block design and latin squares, crossover design, incomplete block designs, split-plot designs.

Unit VI: Two-Level Fractional Factorial Designs: Introduction the One-Half Fraction of the 2^k Design, Definitions and Basic Principles, Design Resolution, Construction and Analysis of the One-Half Fraction, The One-Quarter Fraction of the 2k Design, The General 2^{k-p}, Fractional Factorial Design , Choosing a Design, Analysis of 2^{k-p} Fractional Factorials ,

Text Books / References:

1. D. Montgomery, “Design and Analysis of Experiments”, Eigth Edition, Wiley, 2013.
2. D. Cox and N. Reid, “The Theory of the Design of Experiments”, CRC Press, 2000.
3. K. Hinkelmann and O. Kempthorne, “Design and Analysis of Experiments, Wiley, 1994.
4. G. Box, J. Hunter and W. Hunter, “Statistics for Experimenters”, Second Edition, Wiley, 2005. 5. G.Oehlert - A First Course in Design and Analysis of Experiments, W.H.Freeman, 2000.

3MCC1 Program Elective –V

(ii) COMPUTER ASSISTED PRODUCTION MANAGEMENT

SECTION-A

Course Objectives:

1. This course aims to provide an overview of production management through Computer Aids
2. Focusing on the computer aided tools applicable in managing automated production, Material Resource Planning & Enterprise Resource Planning.
3. Holistic approach to improve and increase the value of Computer Aided tools in Production Management

Course Outcomes:

1. Understand relevance and importance of the Different Production and operations management techniques and their applications.
2. Capable to design, analyze and assess production planning and control systems, including those operating within distributed manufacturing environment.
3. Be able to develop simulation of machine shop.
4. Gain an overall understanding of computer aided production management.

Unit I: Computer aided process planning: Approaches to CAPP, basic part representation methods, shape producing capabilities, Process economics.

Unit II: Computer assisted QC: co-ordinate measuring machinesconstruction and types, automated dimensional gauging and in process gauging.

Unit III: Capacity planning: Roll of capacity planning in manufacturing, planning and control systems, hierarchy of capacity planning decisions links to other system modules, capacity planning and control techniques.

SECTION-B

Unit IV: Just in time: JIT in manufacturing planning and control, leveling the production, pull system introduction, product and process design, JIT applications.

Unit V: Computer aided inventory control: Computer aided purchasing procedure, simulation of inventory problems.

Unit VI: Computer aided materials management: Material requirement planning, computer integrated materials management.

References:

1) Groover M.P.- Automation, Production Systems and CIM.
2) David Bedworth, M.R. Handerson & Philip Wilze- Computer Integrated Design and manufacturing

3MCC1 Programme Elective-V (iii) ERGONOMICS

Course Objectives:

1) Design and redesign tasks and workstations to fit employees.
2) Be exposed to principles of ergonomics.
3) Learn the mechanics of muscle physiology.

Course Outcomes:

1) Understand principles of ergonomics.
2) Design biomedical devices.

SECTION-A

Unit-I: Introduction: ergonomics and man machine systems. Basic ergonomics, Work phycology and method of measurement of work, Paced & Un-paced performance. Design & selection of displays and controls. Application of anthropometric data and design of workplace. Layouts, Environmental studies, industrial safety & training, case studies.

Unit-II: Visual and Auditory Ergonomics: Process of seeing – visual capabilities-factors affecting visual acuity and contrast sensitivity – human factor aspects of hard copy text and computer screen text, factors in selecting graphic representations symbols, qualitative visual display-process of hearing-principles of auditory display.

Unit-III:Muscle physiology -muscle metabolism-respiratory response-joint motion study- measure of physiological in-efficiency and energy consumption-work rest cycles-aspects of manual and posture study, material handling (MMH) Bio-mechanical recommended limits of MMH.

SECTION-B

Unit-IV: Controls and Displays: Spatial compatibility physical arrangement of displays and controls- movement capability- rotary controls and rotar displays movement of displays orientation of the operator and movement relationships control orders and control responses- human limitations in tracking task.

Unit-V: Anthropometry- anthropometric design principles –work space envelope- factors in design of work space surfaces- principles of seat design –principles of control panel. Organization classification of human errors theories of accident causation-reducing accidents by altering behavior.

Unit-VI:Case Studies: Case Study 1: computer design, control panel design of an electronic instrument, computer key board, hand drill etc. Case Study 2: Biomedical Application, Design optimization of Medical Equipments.

Books Recommended:

1) Ergonomics Design for People at Work, Vol.I& II : Eastman Kodak Co.
2) A Guide to the Ergonomics of Manufacturing : Martin Heylander, East West Press, Teylor & Fransis.
3) Ergonomics : Man in his Working Environment : K.F.H. Murrel, Chhapman& Hall Ltd., U.S.A.
4) Ergonomics at Work : David J.Oborn, John Wiley &Sons, New York.
5) Motion & Time Studies : Ralph M.Barnes, John Wiley & Sons.
6) Motion & Time Studies : Martin E. Muldel, PHI.
7) Hand Book of Industrial Engg. : Gavriel Salvendy, John Wiley & Sons.
8) Pascale Carayon, Handbook of Human Factors and Engineering, Second Edition, CRC Press, 2011
9) Robert.N. Bailey, Human Performance Engineering, Third Edition, 1996.

3MCC2 Open Elective (i) BUSINESS ANALYTICS

Course objectives:

1. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making;
2. To become familiar with the processes needed to acquire and prepare data, develop, fit, validate and deploy models and use them for decision making;
3. To learn how to use and apply selected business analytics software (SAS enterprise miner / Rapid Miner).

Course Outcomes:

Upon completion of this course, students will be able to complete the following key tasks:

1. Gain an understanding of how managers use BA to formulate and solve business problems
2. Describe and interpret the basic concepts of BA.
3. Evaluate business problems and determine suitable analytical methods
3. Plan, organize and evaluate methods to prepare raw data for business analytics, including partitioning data and imputing missing values
4. Compare and contrast various descriptive and predictive BA techniques
5. Analyze, Interpret and validate the results extracted from data mining and statistical algorithms.

SECTION-A

Unit I: Descriptive Statistics Meaning, Scope, types, functions and limitations of statistics, Measures of Central tendency – Mean, Median, Mode, Quartiles, Measures of Dispersion – Range, Inter quartile range, Mean deviation, Standard deviation, Variance, Coefficient of Variation, Skewness and Kurtosis.

Unit II: Time Series & Index Number Time series analysis: Concept, Additive and Multiplicative models, Components of time series, Trend analysis: Least Square method - Linear and Non- Linear equations, Applications in business decision-making. Index Numbers:- Meaning , Types of index numbers, uses of index numbers, Construction of Price, Quantity and Volume indices:- Fixed base and Chain base methods.

Unit III: Correlation & Regression Analysis Correlation Analysis: Rank Method & Karl Pearson's Coefficient of Correlation and Properties of Correlation. Regression Analysis: Fitting of a Regression Line and Interpretation of Results, Properties of Regression Coefficients and Relationship between Regression and Correlation.

SECTION-B

Unit IV: Probability Theory & Distribution Probability: Theory of Probability, Addition and Multiplication Law, Baye's Theorem Probability Theoretical Distributions: Concept and application of Binomial; Poisson and Normal distributions.

Unit V: Hypothesis Testing& Business Analytics Hypothesis Testing: Null and Alternative Hypotheses; Type I and Type II errors; Testing of Hypothesis: Large Sample Tests, Small Sample test, (t, F, Z Test and Chi Square Test)

Unit VI: Concept of Business Analytics- Meaning types and application of Business Analytics, Use of Spread Sheet to analyze data-Descriptive analytics and Predictive analytics.

Reference Books:

1. G C Beri – Business Statistics, 3rd ed, TATA McGrawHill.
2. Chandrasekaran &Umaparvathi-Statistics for Managers, 1st edition, PHI Learning
3. Davis , Pecar – Business Statistics using Excel, Oxford
4. Ken Black – Business Statistics, 5th ed., Wiley India
5. Levin and Rubin – statistics for Management,
6. Lind, Marchal, Wathen – Staistical techniques in business and economics, 13th ed, McGrawHil
7. Newbold, Carlson, Thorne – Statistics for Business and Economics, 6th ed., Pearson
8. S. C.Gupta – Fundamentals of Statistics, Himalaya Publishing
9. Walpole – Probability and Statistics for Scientists and Engineers, 8th ed., Pearson.

Text Books:

1. Probability and Statistics for Engineers and scientists by Anthony J. Hayter, Cencage Learning, 4th Edition 2016 2.
2. Probability and Statistics for Engineers and scientists by Walpole, Myers, Myers and Ye, 8th ed Pearson Education, 2007
3. Research Methodology - Methods and Techniques, C. K. Kothari, NewAge International, 2nd Edition 2004
4. English for writing research papers by Adrian Wallwork, 2nd Edition, Springer 2016
5. Statistics: Concepts and Controversies by David S. Moore, William I. Notz, W. H. Freeman 2016.

3MCC2 Open Elective (ii) INDUSTRIAL SAFETY

Course Objectives:

- To provide exposure to the students about safety and health provisions related to hazardous processes as laid out in Factories act 1948.
- To familiarize students with powers of inspectorate of factories.
- To help students to learn about Environment act 1948 and rules framed under the act.
- To provide wide exposure to the students about various legislations applicable to an industrial unit.

Course Outcomes:

- Upon completion of the course the students will be able
- To list out important legislations related to health, Safety and Environment.
- To list out requirements mentioned in factories act for the prevention of accidents.
- To understand the health and welfare provisions given in factories act.
- To understand the statutory requirements for an Industry on registration, license and its renewal.
- To prepare onsite and offsite emergency plan.

Unit I: FACTORIES ACT – 1948 10 Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes, welfare – special provisions – penalties and procedures-Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948 - Tamilnadu safety officer rules 2005.

Unit II: WATER POLLUTION 13 Classification of water pollutants-health hazards-sampling and analysis of water-water treatment - different industrial effluents and their treatment and disposal –advanced wastewater treatment - effluent quality standards and laws- chemical industries, tannery, textile effluents-common treatment.

Unit III: HAZARDOUS WASTE MANAGEMENT 11 Hazardous waste management in India-waste identification, characterization and classification-technological options for collection, treatment and disposal of hazardous waste-selection charts for the treatment of different hazardous wastes-methods of collection and disposal of solid wastes-health hazards-toxic and radioactive wastes incineration and vitrification - hazards due to bio-process-dilution standards and restrictions – recycling and reuse. Environmental impact assessment (EIA)-scope, guidelines, activities and methodologies.

Unit IV: ENVIRONMENTAL MEASUREMENT AND CONTROL 13 Sampling and analysis – dust monitor – gas analyzer, particle size analyzer – lux meter, pH meter – gas chromatograph – atomic absorption spectrometer. Gravitational settling chambers-cyclone separators-scrubbers electrostatic precipitator - bag filter – maintenance - control of gaseous emission by adsorption, absorption and combustion methods- Pollution Control Board-laws.

Unit V: POLLUTION CONTROL IN PROCESS INDUSTRIES 10 Pollution control in process industries like cement, paper, petroleum petroleum products textile- tanneries-thermal power plants – dying and pigment industries - eco-friendly energy.

Reference Books:

1. Rao C S, “Environmental Pollution Control Engineering”, New Age International, 2007.
2. Mahajan S.P, “Pollution Control in Process Industries”, Tata McGraw Hill Publishing Company, New Delhi, 2004.
3. Varma and Braner, “Air pollution equipment”, Springer Publishers, Second Edition.
4. “Guidelines for EIA of Industrial and other Projects” Ministry of Environment and Forests, Government of India, 2009.
5. Pollution Control Law Series: Pollution Control Acts, Rules and Notification Issued There under, Central Pollution Control Board, Ministry of Environment and Forest,
6. Government of India, 2006.
7. Cheremisinoff N.P. and Graffia M.L., “Environmental Health and Safety Management: A Guide to Compliance”, William Andrew Publishing/Noyes, 1995.
8. Cheremisinoff N.P. “Pressure Safety Design Practices for Refinery and Chemical Operations”, Jaico Publication, 2003.
9. Canter L.W., “Environmental Impact Assessment”, Mc-Graw Hill. 1996.

3MCC2 Open Elective (iii) OPERATION RESEARCH

Course Objective:

This course provides strong foundation for understanding the fundamental principles and laws of Operation Research to understand Linear programming, network Analysis and queuing, replacementmodels. Students can understand and solve the problems regarding management and application of various models.

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Course Outcomes:

1. Identify and develop operational research models from the verbal description of the real system.
2. Understand the mathematical tools that are needed to solve optimization problems.
3. Use mathematical software to solve the proposed models.
4. Develop a report that describes the model and the solving technique, analyze the results and propose
5. recommendations in language understandable to the decision-making processes in Management Engineering.

Unit – I: Introduction: Origin of Operation Research, Historical Standpoint, Methodology, Different Phases, Characteristics, Scope and Application of Operations Research.

Unit – II: Linear Programming (LP) : Concepts, Formulation of model, Graphical solution, Maximization / Minimization – Simplex Algorithm, Use of slack / surplus / artificial variables, Big M and Two phase method – Nature & type of solutions, Interpretation of optimal solution. Dual problem – relation between primal and dual, Dual simplex method – Interpretation of dual variables, Introduction to Integer programming, Economic Interpretation.

Unit – III: Transportation & Assignment problems: Concepts, formulations of models, Solution procedures, Optimality checks, Balanced/Unbalanced, Maximum/Minimum problems, Prohibited case – degeneracy.

Unit – IV: Replacement Models: Introduction, Replacement of capital equipment which depreciated with time, replacement by alternative equipment, Group and individual replacement policy.

Unit – V: Game Theory: Introduction, Characteristics of Game Theory, Two Person, Zero sum games, Pure strategy. Dominance theory, Mixed strategies (2x2, mx2), Algebraic and graphical methods. Decision Theory: Introduction, Decision under certainty, Decision under risk, Decision under uncertainty: Laplace criterion, MaxiMin criterion, Mini Max criterion, savage Mini Max regret criterion, hurwicz criterion, Decision tree.

Unit – VI: Queuing Models: Basis of Queuing theory, elements of queuing theory, Kendall's Notation, Operating characteristics of a queuing system, Classification of Queuing models, Project Management: Introduction to PERT and CPM, critical Path calculation, float calculation and its importance. Cost reduction by Crashing of activity.

Reference Books:

1. Quantitative Techniques in management, N.D. Vora – Tata McGraw Hill.
2. Operations Research – An Introduction – Fifth edition by Hamdy A Taha- Prentice Hall of India, New Delhi.
3. Principles of Operations Research: With Applications to Management Decisions, Wagner, H.M. , Prentice-Hall of India, New Delhi, 1982.
4. Hillier, F.S. and Lieberman, G.J., Operations Research, Holden Day Inc., San Francisco, 1974.
5. Littlechild, S.C. (ed), Operational Research for Managers, Philip Allan, Oxford, 1977.
6. Mitchell, G.H. (ed), Operational Research Techniques and examples, The English Universities Press Ltd., London, 1972. Moder, J.J. and Elmaghraby, S.E. (ed.), Handbook of Operations Research: Models and Applications, Van Nostrand Reinhold Co., New York, 1987.
7. Payne, T. A., Quantitative Techniques for Management: A Practical Approach, Reston

3MCC2 Open Elective

(iv) COST MANAGEMENT OF ENGINEERING PROJECTS

Course Objectives:

• Summarize the costing concepts and their role in decision making Infer the project management concepts and their various aspects in selection Interpret costing concepts with project execution Develop knowledge of costing techniques in service sector and various budgetary control techniques Illustrate with quantitative techniques in cost management.

Course Outcomes:

- Understand the costing concepts and their role in decision making.
- Understand the project management concepts and their various aspects in selection.

Unit I: Introduction To Costing Concepts: Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.'

Unit II: Introduction To Project Management: Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts

Unit III: Project Execution And Costing Concepts: Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing

Unit IV: Costing Of Service Sector And Budgetary Control: Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

Unit V: Quantitative Techniques For Cost Management:

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

Reference Books:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991.
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988.

3MCC2 Open Elective (v) COMPOSITE MATERIALS

Course Objectives:

1) Train students on composite materials – definition, advantages and classification.
2) Equip students with knowledge on composite strengthening addition of components and their production routes.
3) Familiarize students about the properties and response of composite structures subjected to mechanical loading.

Course Outcomes:

1) Identify and understand the basic mechanical behavior of composite materials and make sound prediction on the likely behavior of new combinations of materials.
2) Apply the choices made for using certain types of composites in certain applications with reference to composite properties.
3) Demonstrate a practical understanding of composite properties and fabrication techniques, and to be able to make realistic suggestions for the evaluation of composite behavior, where appropriate.

SECTION-A

Unit-I: Introduction: Introduction and overview of composite materials and their need, Enhancement of properties, classification of composites, Matrix-Polymer matrix composites (PMC), Metal matrix composites (MMC), Ceramic matrix composites (CMC), Application of composites.

Unit-II: Reinforcements Materials: Metallic, Polymer, Ceramic and Composite fibres, Whiskers and Particulates, Nano-fillers used in polymer composites, Reinforcement fibres, Woven fabrics and Nonwoven random mats. **Types of matrix:** Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Intermetallic matrix, Carbon-Carbon composites), Basic Requirements in Selection of constituents.

Unit-III: Production techniques and Properties: Processing of cast composites - XD process, Spray processes (Osprey Process, Rapid solidification processing), In-situ Dispersion Processes (Stir-casting & Compo casting, Screw extrusion), Liquidmetal impregnation technique (Squeeze casting, Pressure infiltration, Lanxide process). Hand lay-up processes – Spray up processes, Compression moulding, Reinforced reaction injection moulding, Resin transfer moulding, Pultrusion, Filament winding, Injection moulding.

Unit IV: Mechanics of Composite Materials: Continuous fibres – iso-stress and iso-strain conditions, discontinuous fibres, Nature of stress *vs*. strain curves for different composite materials.

Unit V: Mechanical Properties: Mechanical testing of composites – tensile, flexure (3 point and 4 pointbend tests), interfacial tests of laminates; Modes of fracture; Toughening mechanisms in composites.

Unit VI: Recent developments in Composites: Self healing composites, Molecular composites, Micro and Nano composites, Bio-composites, Left handed composites, Stiffer than stiff composites, Carbon / carbon composites (Advantages and limitations of carbon matrix).

Text Book: Chawla K.K., Composite materials, Springer, New York, 1998.

Reference books:

1. Mathews F.L. and Rawlings R.D., Composite materials: Engineering and Science, Chapman
2. and Hall, London, England, 1st edition, 1994.
3. Strong A.B., Fundamentals of Composite Manufacturing, SME, 1989.
4. Sharma S.C., Composite materials, Narosa Publications, 2000.
5. Mallick, P.K, Composite Materials Technology: Process and Properties, Hanser, New York, 1990.

3MCC2 Open Elective (vi) WASTE TO ENERGY

Course Objectives:

1) To enable students to understand of the concept of Waste to Energy.
2) To link legal, technical and management principles for production of energy form waste.
3) To learn about the best available technologies for waste to energy.
4) To analyze of case studies for understanding success and failures.
5) To facilitate the students in developing skills in the decision making process.

Course Outcomes:

1) Apply the knowledge about the operations of Waste to Energy Plants.
2) Analyze the various aspects of Waste to Energy Management Systems.
3) Carry out Techno-economic feasibility for Waste to Energy Plants.
4) Apply the knowledge in planning and operations of Waste to Energy plants.

SECTION-A

Unit-I: Introduction The Principles of Waste Management and Waste Utilization. Waste Management Hierarchy and 3R Principle of Reduce, Reuse and Recycle. Waste as a Resource and Alternate Energy source.

Unit-II: Waste Sources & Characterization Waste production in different sectors such as domestic, industrial, agriculture, postconsumer, waste etc. Classification of waste – agro based, forest residues, domestic waste, industrial waste (hazardous and non-hazardous). Characterization of waste for energy utilization. Waste Selection criteria.

Unit-III: Technologies for Waste to Energy Biochemical Conversion – Energy production from organic waste through anaerobic digestion and fermentation. Thermo-chemical Conversion – Combustion, Incineration and heat recovery, Pyrolysis, Gasification; Plasma Arc Technology and other newer technologies.

SECTION-B

Unit-IV: Waste to Energy Options Landfill gas, collection and recovery. Refuse Derived Fuel (RDF) – fluff, briquettes, pellets. Alternate Fuel Resource (AFR) – production and use in Cement plants, Thermal power plants and Industrial boilers. Conversion of wastes to fuel resources for other useful energy applications. 4 2 Energy from Plastic Wastes – Non-recyclable plastic wastes for energy recovery. Energy Recovery from wastes and optimization of its use, benchmarking and standardization. Energy Analysis.

Unit-V: Centralized and Decentralized Waste to Energy Plants Waste activities – collection, segregation, transportation and storage requirements. Location and Siting of 'Waste to Energy' plants. Industry Specific Applications – In-house use – sugar, distillery, pharmaceuticals, Pulp and paper, refinery and petrochemical industry and any other industry. Centralized and Decentralized Energy production, distribution and use. Comparison of Centralized and decentralized systems and its operations.

Unit-VI: Waste To Energy & Environmental Implications Environmental standards for Waste to Energy Plant operations and gas clean-up. Savings on non-renewable fuel resources. Carbon Credits: Carbon foot calculations and carbon credits transfer mechanisms.

Books Recommended:

1) Dr Suneel Pande, Senior Fellow & Director Environment TERI, IHC, New Delhi
2) Dr Dinesh Pant, Fellow, Division Energy – Environment Technology, TERI, IHC, New Delhi
3) Mr Ulhas Parlikar, Dy Head Geocycle India –ACC Limited, Mumbai.

3MMC3 Dissertation Phase-I (SEMESTER-III) and 4MCC01 Dissertation Phase-II (SEMESTER-IV)

Course Objectives:

1. Ability to synthesize knowledge and skills previously gained and applied to an in-depth study and execution of new technical problem.
2. Capable to select from different methodologies, methods and forms of analysis to produce a suitable research design, and justify their design.
3. Ability to present the findings of their technical solution in a written report.
4. Presenting the work in International/ National conference or reputed journals.

Course Outcomes:

1. Design a research investigation that incorporates appropriate theoretical approaches, conceptual models, and a review of the existing literature.
2. Structure a discussion in a coherent and convincing way by summarizing the key arguments and providing suitable and coherent findings.
3. Draw valid conclusions, relating them to the research topic.
4. Write a comprehensive review of the literature, including a review of other dissertation research related to their study.
5. Develop a design of their study with a discussion of the methodology to be used. Students describe how their data will be treated and analyzed of their study.

Syllabus Contents:

The dissertation / project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The dissertation should have the following:

- Relevance to social needs of society
- Relevance to value addition to existing facilities in the institute
- Relevance to industry need
- Problems of national importance
- Research and development in various domains

The student should complete the following:

- Literature survey Problem Definition
- Motivation for study and Objectives
- Preliminary design / feasibility / modular approaches
- Implementation and Verification
- Report and presentation

The dissertation stage II is based on a report prepared by the students on dissertation allotted to them.

It may be based on:

- Experimental verification / Proof of concept.
- Design, fabrication, testing of Communication System.
- The viva-voce examination will be based on the above report and work.

Guidelines for Dissertation Phase- I and II

• As per the AICTE directives, the dissertation is a yearlong activity, to be carried out and evaluated in two phases i.e. Phase – I: July to December and Phase – II: January to June.

• The dissertation may be carried out preferably in-house i.e. department's laboratories and centers OR in industry allotted through department's T & P coordinator.

• After multiple interactions with guide and based on comprehensive literature survey, the student shall identify the domain and define dissertation objectives. The referred literature should preferably include Springer/Science Direct. In case of Industry sponsored projects, the relevant application notes, while papers, product catalogues should be referred and reported.

• Student is expected to detail out specifications, methodology, resources required, critical issues involved in design and implementation and phase wise work distribution and submit the proposal within a month from the date of registration.

• Phase-I deliverables: A document report comprising of summary of literature survey, detailed objectives, project specifications, paper and/or computer aided design, proof of concept/functionality, part results, A record of continuous progress.

• Phase-I evaluation: A committee comprising of guides of respective specialization shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend repeating the phase-I work.

• During Phase-II, student is expected to exert on design, development and testing of the proposed work as per the schedule. Accomplished results/contributions/innovations should be published in terms of research papers in reputed journals and reviewed focused conferences OR IP/Patents.

• Phase-II deliverables: A dissertation report as per the specified format, developed system in the form of hardware and/or software, A record of continuous progress.

• Phase-II evaluation: Guide along with appointed external examiner shall assess the progress/performance of the student based on report, presentation and Q & A. In case of unsatisfactory performance, committee may recommend for extension or repeating the work

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