BONAM VENKATA CHALAMAYYA ENGINEERING COLLEGE
(An Autonomous Institution)
Department of Mechanical Engineering
M. TECH (BR25) ADVANCED MANUFACTURING SYSTEMS
COURSE STRUCTURE & SYLLABUS

I Year II Semester	ADVANCED FINITE ELEMENT METHODS (Program Core 4) (25AM1T04)	L	T	P	C
		3	1	0	4

COURSE OBJECTIVES:

1. The course's goal is to familiarize students with the fundamentals of the Finite Element Technique, a numerical method for solving various practical and the method's fundamentals will eventually be covered before moving on to various areas of implementation.
2. To present analytical approaches for structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

CO1 Apply several kinds of computational methods to develop and evaluate the governing equations for various engineering problem (K3&K5)

CO2 Develop, solve, and analyse problems involving one-dimensional axially loaded bars, trusses, and beam elements (K3&K4)

CO3 Apply the numerical methods of FEM to derive element matrices. Solve and analyse two dimensional CST, axi-symmetric problems subjected to various boundary conditions (K3&K4)

CO4 Apply and develop the solutions for the numerous engineering problems using the concepts of iso-parametric formulation and convergence techniques (K3)

CO5 Evaluate various engineering problems subjected to dynamic and thermal conditions for optimum solutions (K5)

UNIT I:

Formulation Techniques: Methodology, Engineering problems and governing differential equations, finite elements., Variational methods potential energy method, Raleigh Ritz method, strong and weak forms, Galerkin and weighted residual methods, calculus of variations, Essential and natural boundary conditions

UNIT – II:

One-Dimensional Problems: Bar, trusses, beams and frames, displacements, stresses and temperature effects.

UNIT – III:

Two Dimensional Problems: CST, Axisymmetric Problems: Axisymmetric formulations,

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Element matrices, boundary conditions.

UNIT – IV:

Iso-Parametric Formulation: Concepts, sub-parametric, super parametric elements, numerical integration, LST, four-nodded and eight-nodded rectangular elements, Lagrange basis for triangles and rectangles, serendipity interpolation functions. Convergence: Requirements for convergence, h refinement and p-refinement, complete and incomplete interpolation functions, pascal's triangle, Patch test

UNIT – V:

Dynamic Problems: Analysis, Eigen value problems, and their solution methods. Heat Transfer problems: Conduction and convection, examples: - One & two-dimensional fin. Introduction to nonlinear problems.

TEXTBOOKS:

1. Finite element methods by Chandrupatla&Belegundu.
2. Finite Element Analysis by P. Seshu, PHI learning private limited, New Delhi.

REFERENCE BOOKS:

1. J.N. Reddy, Finite element method in Heat transfer and fluid dynamics, CRC press,1994
2. Zienckiwicz O.C. and R. L. Taylor, Finite Element Method, McGraw-Hill,1983
3. K. J. Bathe, Finite element procedures, Prentice-Hall, 1996
4. Concepts and applications of finite element analysis, R.D.Cook et al. Wiley

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.

	online	online	online	online	
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COURSE STRUCTURE & SYLLABUS

I Year II Semester	COMPUTER INTEGRATED MANUFACTURING (Programme Core 5) (25AM1T05)	L	T	P	C
		3	1	0	4

Course Objectives

The course is designed to:

1. Provide foundational knowledge of CAD/CAM systems and the concepts of Computer Integrated Manufacturing (CIM).
2. Develop an understanding of production planning and control systems, including CAPP, MRP-II, and ERP.
3. Introduce Group Technology and Cellular Manufacturing concepts, including part classification and machine cell design.
4. Explain Flexible Manufacturing Systems (FMS) and Automated Guided Vehicle Systems (AGVS) with their applications and analysis.
5. Familiarize students with the fundamentals of industrial robotics, including anatomy, control systems, sensors, and programming.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

CO No.	Course Outcome	Bloom's Level
CO1	Explain the components, models, and levels of automation in a CIM system, including lean and JIT principles.	Understand
CO2	Develop basic production planning and control strategies using CAPP, MRP, and ERP systems.	Apply / Analyze
CO3	Apply Group Technology concepts and solve simple problems related to part coding, machine layout, and clustering.	Apply / Analyze
CO4	Analyze FMS configurations and AGVS technologies for planning and control in automated manufacturing systems.	Analyze / Evaluate
CO5	Describe the structure, programming, and applications of industrial robots in manufacturing automation.	Understand / Apply

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UNIT I

INTRODUCTION- Brief introduction to CAD and CAM – Manufacturing Planning, Manufacturing control Introduction to CAD/CAM – CIM concepts – Computerised elements of CIM system –Types of production - Manufacturing models and Metrics – Mathematical models of Production Performance – Simple problems – Manufacturing Control – Simple Problems – Basic Elements of an Automated system – Levels of Automation – Lean Production and Just-In Time Production

UNIT II

PRODUCTION PLANNING AND CONTROL AND COMPUTERISED PROCESS PLANNING

Process planning – Computer Aided Process Planning (CAPP) – Logical steps in Computer Aided Process Planning – Aggregate Production Planning and the Master Production Schedule – Material Requirement planning – Capacity Planning- Control Systems-Shop Floor Control Inventory Control – Brief on Manufacturing Resource Planning-II (MRP-II) & Enterprise Resource Planning (ERP) - Simple Problems.

UNIT III

CELLULAR MANUFACTURING

Group Technology (GT), Part Families – Parts Classification and coding – Simple Problems in Opitz Part Coding system – Production flow Analysis – Cellular Manufacturing – Composite part concept – Machine cell design and layout – Quantitative analysis in Cellular Manufacturing – Rank Order Clustering Method - Arranging Machines in a GT cell – Hollier Method – Simple Problems.

UNIT IV

FLEXIBLE MANUFACTURING SYSTEM (FMS) AND AUTOMATED GUIDED VEHICLE

SYSTEM (AGVS) Types of Flexibility - FMS – FMS Components – FMS Application & Benefits – FMS Planning and Control– Quantitative analysis in FMS – Simple Problems. Automated Guided Vehicle System (AGVS) – AGVS Application – Vehicle Guidance technology – Vehicle Management & Safety

UNIT V

INDUSTRIAL ROBOTICS

Robot Anatomy and Related Attributes – Classification of Robots- Robot Control systems – End Effectors – Sensors in Robotics – Robot Accuracy and Repeatability - Industrial Robot

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Applications – Robot Part Programming – Robot Accuracy and Repeatability – Simple Problems.

TEXT BOOK:

1. Mikell.P.Groover —Automation, Production Systems and Computer Integrated Manufacturing‖, Prentice Hall of India, 2008.
2. Radhakrishnan P, Subramanyan S.and Raju V., —CAD/CAM/CIM‖, 2nd Edition, New Age International (P) Ltd, New Delhi, 2000.

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COURSE STRUCTURE & SYLLABUS

I Year II Semester	ADVANCED CNC TECHNOLOGIES (Programme Core 6) (25AM1T06)	L	T	P	C
		3	1	0	4

Course Objectives

The course is designed to:

1. Introduce the fundamentals of Numerical Control (NC) and Computer Numerical Control (CNC) systems, including their classifications, components, and machine features.
2. Provide knowledge of NC part programming using both manual and computer-aided methods, including APT and CAD/CAM-based programming.
3. Explain the role of post processors, interpolators, and automatic tool path generation in CNC systems.
4. Familiarize students with tooling systems, Direct Numerical Control (DNC), and adaptive control techniques used in modern CNC machines.
5. Introduce microcontrollers and Programmable Logic Controllers (PLCs) used in CNC control systems, including their structure, programming, and applications.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

CO No.	Course Outcome	Bloom's Level
CO1	Describe the principles, components, and classifications of NC/CNC machines and their drive and feedback systems.	Understand
CO2	Develop NC part programs using manual and computer-aided programming approaches for various machining operations.	Apply
CO3	Explain the functions and structure of post processors and interpolators used in CNC systems.	Understand / Analyze
CO4	Evaluate tooling systems, DNC architecture, and adaptive control strategies for enhanced CNC machining performance.	Analyze / Evaluate
CO5	Apply knowledge of microcontrollers and PLCs to understand control mechanisms and programming in CNC machines.	Apply

UNIT I:

Features of NC Machines Fundamentals of numerical control, advantage of NC systems,

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classification of NC systems, point to point, NC and CNC, incremental and absolute, open and closed loop systems, Features of NC Machine Tools, design consideration of NC machine tool, methods of improving machine accuracy. Systems Drives and Devices: Hydraulic motors, DC motors, stepping motors and AC motors, feedback devices, encoders, Induction tachometers.

UNIT II:

NC Part Programming: Manual programming-Basic concepts, Point to Point contour programming, canned cycles, parametric programming. Computer-Aided Programming: General information, APT programming, Examples APT programming problems (2D machining only). NC programming on CAD/CAM systems,

UNIT III:

Post Processors: Introduction to post processors, necessity of post processors, general structure of a post processor, functions of a post processor. Automatic tool path generation. Interpolators: DDA integrator, hardware interpolators for linear and circular interpolator, DDA software interpolators and CNC software interpolators, the reference pulse technique, sampledata technique.

UNIT IV:

Tooling for CNC machines: Inter changeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers. DNC SYSTEMS AND Adaptive Control: Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, Adaptive control with constraints, Adaptive control of machining processes like turning, grinding

UNIT V:

Micro Controllers: Introduction, Hardware components, I/O pins, ports, external memory, counters, timers and serial data I/O interrupts. Selection of Micro Controllers, Embedded Controllers,

Applications and Programming of Micro Controllers. Programmable Logic Controllers (PLC's): Introduction, Hardware components of PLC, System, basic structure, principle of operations, Programming mnemonics timers, Internal relays and counters, Applications of PLC's in CNC Machines.

TEXT BOOKS:

1. Computer Control of Manufacturing Systems / Yoram Koren / Mc Graw Hill Int. 1983.
2. Machining Tools Hand Book Vol 3, (Automation & Control)/ Manfred Weck / John Wiley and Sons, 1984

	online	online	online	online	
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COURSE STRUCTURE & SYLLABUS

I Year II Semester	SMART MATERIALS (PROGRAM ELECTIVE-3) (25AM1D09)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Knowing the behavior of Piezoelectric and magnetostrictive materials and their suitability as sensors in smart structures.
2. Understanding the behavior of IPMC, Shape memory alloys and Rhelogical fluids and applied as Biometric sensors, as actuators in medical devices, aerospace and automotive industry, and as insulating membrane in bearings respectively.
3. Studying about different sensors and their role in health monitoring systems.
4. Develop different actuators for vibration control.
5. Designing the smart systems using self sensing and self healing systems.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:
CO1 Knowing the behavior of Piezoelectric and magnetostrictive materials and their suitability as sensors in smart structures (K2).
CO2 Understanding the behavior of IPMC, Shape memory alloys and Rhelogical fluids and applied as Biometric sensors, as actuators in medical devices, aerospace and automotive industry, and as insulating membrane in bearings respectively (K2).
CO3 Studying about different sensors and their role in health monitoring systems (K2 & K4)
CO4 Develop different actuators for vibration control (K3&K6).
CO5 Designing the smart systems using self sensing and self healing systems (K6)

UNIT – I:

Introduction: Introduction to Smart Materials, Principles of Piezoelectricty, PerovskytePiezoceramic Materials, Single Crystals vs Polycrystalline Systems, Piezoelectric Polymers, Principles of Magnetostriction, Rare earth Magnetostrictive materials, Giant Magnetostriction and Magneto-resistance Effect.

UNIT – II:

Introduction to Electro-active Materials, Electronic Materials, Electro-active Polymers, Ionic Polymer Matrix Composite (IPMC), Shape Memory Effect, Shape Memory Alloys, Shape

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Memory Polymers, Electro-rheological Fluids, Magneto Rhelological Fluids.

UNIT – III:

Piezeoelctric Strain Sensors, In-plane and Out-of Plane Sensing, Shear Sensing, Accelerometers, Effect of Electrode Pattern, Active Fibre Sensing, Magnetostrictive Sensing, Villari Effect, Matteuci Effect and Nagoka-Honda Effect, Magnetic Delay Line Sensing, Application of Smart Sensors for Structural Health Monitoring (SHM), System Identification using Smart Sensors.

UNIT – IV:

Modelling Piezoelectric Actuators, Amplified Piezo Actuation – Internal and External Amplifications, Magnetostrictive Actuation, Joule Effect, Wiedemann Effect, Magnetovolume Effect, Magnetostrictive Mini Actuators, IPMC and Polymeric Actuators, Shape Memory Actuators, Active Vibration Control, Active Shape Control, Passive Vibration Control, Hybrid Vibration Control.

UNIT – V:

Self-Sensing Piezoelectric Transducers, Energy Harvesting Materials, Autophagous Materials, Self-Healing Polymers, Intelligent System Design, Emergent System Design.

TEXT BOOKS:

1. Brian Culshaw, Smart Structures and Materials, Artech House, 2000
2. Functional and Smart materials by Z L Wang and Z C Kang, Plenium Press
3. Gauenzi, P., Smart Structures, Wiley, 2009

REFERENCE BOOKS:

1. Cady, W. G., Piezoelectricity, Dover Publication
2. Smart materials: Integrated design, Engineering approaches and potential applications, AncaFilimon, Apple Academic Press

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.

	online	online	online	online	Naveen
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COURSE STRUCTURE & SYLLABUS

I Year II Semester	PRODUCTION AND OPERATION MANAGEMENT (Program Elective 3) (25AM1D10)	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce the fundamentals of operations management, production systems, and product design concepts including concurrent engineering.
2. To explain value engineering principles, plant location, and layout strategies for effective production management.
3. To familiarize students with aggregate planning, inventory control, MRP, MRP-II, and Just-In-Time (JIT) production systems.
4. To develop understanding of project management techniques such as PERT, CPM, and project crashing for efficient project execution.
5. To provide insights into supply chain management concepts, processes, and decision-making models for optimized operations.

Course Outcomes (COs)

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

CO No.	Course Outcome	Bloom's Level
CO1	Explain the core concepts of operations management, product design, and concurrent engineering principles.	Understand
CO2	Apply value engineering techniques and determine suitable plant location and layout for manufacturing facilities.	Apply
CO3	Analyze and formulate aggregate production plans and inventory control strategies including MRP and JIT systems.	Analyze
CO4	Use project management tools like PERT and CPM to plan, schedule, and control projects effectively.	Apply / Analyze
CO5	Describe supply chain management concepts and apply SCM models to improve organizational performance.	Understand / Apply

	online	online	online	Online	
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UNIT -I

OPERATION MANAGEMENT: Definition – Objectives – Types of production systems – historical development of operations management – Current issues in operation management. Product design – Requirements of good product design – product development – approaches – concepts in product development – standardization – simplification – Speed to market – Introduction to concurrent engineering.

UNIT – II

VALUE ENGINEERING: objective – types of values – function & cost – product life cycle-steps in value engineering – methodology in value engineers – FAST Diagram – Matrix Method. Location – Facility location and layout – Factors considerations in Plant location-Comparative Study of rural and urban sites – Methods of selection plant layout – objective of good layout – Principles – Types of layout – line balancing.

UNIT - III

AGGREGATE PLANNING: definition – Different Strategies – Various models of Aggregate Planning.

Advance inventory control systems push systems – Material Requirement – Terminology – types of demands – inputs to MRP- techniques of MRP – Lot sizing methods – benefits and drawbacks of MRP –Manufacturing Resources Planning (MRP –II), Pull systems – Vs Push system – Just in time (JIT) philosophy Kanban System – Calculation of number of Kanbans Requirements for implementation JIT – JIT Production process – benefits of JIT.

UNIT - IV

PROJECT MANAGEMENT: Programming Evaluation Review Techniques (PERT) – three times estimation – critical path – probability of completion of project – critical path method – crashing of simple nature.

UNIT – V

SUPPLY CHAIN MANAGEMENT: Concepts, process of SCM, selection of channel strategy, core operations capabilities, SCM decisions, SCM models.

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TEXT BOOKS:

1. Operations Management/ E.S. BuffA/ John Wiley & Sons / 2007
2. Production and Operations Management/ Chary/ Mc Graw Hill/2004

REFERENCES:

1. Operations Management Theory and Problems/ Joseph G. Monks / Macmillan / McGraw Hill / 3rd Edition.
2. Production and Operations Management - Theory and Practice by Dipak Kumar Battacharyya, Universities Press Pvt Ltd, 2012.
3. Production Systems Management/ James I. Riggs / John Wiley & Sons.
4. Operations Management/ Richard Chase/ Mc Graw Hill/2006
5. Production and Operation Management / Panner Selvam / PHI.
6. Production and Operation Analysis/ Nahima/ Mc Graw Hill/2004

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I Year II Semester	MEMS: DESIGN AND MANUFACTURING (PROGAM ELECTIVE-3) (25AM2D11)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. Basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques.
2. To design, analysis, fabrication and testing the MEMS based components.
3. To find various opportunities in the emerging field of MEMS about the application and utility of Mechatronics used in various sectors and fields.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:
CO1 Synthesize and characterize nanomaterials for engineering applications (K3&K4)
CO2 Design and analyze methods and tools for micro and nano manufacturing (K2&K3).
CO3 Improve the quality of MEMS by analyzing the variables of the underlying micro and nano manufacturing method (K2).
CO4 Apply the concepts of thermo fluid engineering (K2&K3).
CO5 Select appropriate industrially-viable process, equipment and tools for a specific product (K2).

UNIT I:

OVERVIEW AND WORKING PRINCIPLES OF MEMS AND MICROSYSTEMS
MEMS & Microsystems, Evolution of Micro fabrication, Microsystems & Microelectronics, Microsystems & Miniaturization, Applications of MEMS in Industries, Micro sensors, Micro actuation, MEMS with Micro actuators Micro accelerometers, Micro fluidics.

UNIT II:

ENGINEERING SCIENCE FOR MICROSYSTEMS DESIGN AND FABRICATION:
Atomic structure of Matter, Ions and Ionization, Molecular Theory of Mater and Intermolecular Force, Doping of Semiconductors, The diffusion Process, Plasma Physics, Electrochemistry, Quantum Physics

UNIT III:

ENGINEERING MECHANICS FOR MICROSYSTEMS DESIGN:
Static Bending of thin Plates, Mechanical Vibration, Thermo mechanics Fracture Mechanics,

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Thin-Film Mechanics, Overview of Finite Element Stress Analysis

UNIT IV:

Design Considerations, Process Design Mechanical Design, Mechanical design using FEM, Design of a Silicon Die for a Micro pressure sensor.

Materials for MEMS: Substrates and Wafers, Active substrate materials, Silicon as a substrate material, Silicon compounds, Silicon Piezo resistors, Gallium Arsenide, Quartz, Piezoelectric Crystals and Polymers and Applications

UNIT V:

Microsystems and their fabrication: Introduction to Micro systems Photolithography, Ion implantation, Diffusion and oxidation, Chemical and Physical vapor deposition, etching, Bulk micro manufacturing, Surface Micromachining, The LIGA Process and Applications.

TEXTBOOKS:

1. Tia-Ran Hsu, MEMS & Microsystems. Design & Manufacturing, TMH 2002
2. Foundation of MEMS/ Chang Liu/Pearson, 2012

REFERENCE BOOKS:

1. An Introduction to Micro electro mechanical Systems Engineering by Maluf M., Artech House, Boston 2000
2. Micro robots and Micromechanical Systems by Trimmer, W.S.N., Sensors & Actuators, Vol 19, 1989.
3. Applied Partial Differential Equations by Trim, D.W., PWS-Kent Publishing, Boston, 1990.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.

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Department of Mechanical Engineering
M. TECH (BR25) ADVANCED MANUFACTURING SYSTEMS
COURSE STRUCTURE & SYLLABUS

I Year II Semester	TOTAL QUALITY MANAGEMENT (PROGRAM ELECTIVE-3) (25AM1D12)	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce the fundamental concepts of Total Quality Management (TQM) and its impact on business performance and organizational culture.
2. To explain the importance of customer focus, customer satisfaction, and benchmarking as part of quality management.
3. To describe the organizational structures and systems required for effective implementation of TQM, including quality circles and productivity improvement techniques.
4. To understand the cost of quality, methods of measuring quality costs, and the use of quality cost information for decision-making.
5. To familiarize students with international quality standards, particularly ISO 9000, certification processes, and their significance in quality management systems.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

CO No.	Course Outcome	Bloom's Level
CO1	Explain the principles and benefits of Total Quality Management and its role in enhancing business performance.	Understand
CO2	Analyze customer needs and apply customer satisfaction and benchmarking techniques to improve quality.	Analyze / Apply
CO3	Organize and implement TQM concepts such as quality circles and productivity enhancement methods within organizations.	Apply / Evaluate
CO4	Calculate and interpret the cost of quality and use this information to guide quality improvement decisions.	Analyze
CO5	Understand and apply ISO 9000 standards and certification processes to develop effective quality management systems.	Apply / Understand

UNIT – I:

INTRODUCTION: The concept of TQM, Quality and Business performance, attitude and

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involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

UNIT – II:

CUSTOMER FOCUS AND SATISFACTION: The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

UNIT – III:

ORGANIZING FOR TQM: The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

UNIT – IV:

THE COST OF QUALITY: Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

UNIT – V:

ISO9000: Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-90. Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system.

TEXT BOOKS:

1. Total Quality Management / Joel E.Ross/Taylor and Franscis Limited
2. Total Quality Management/P.N.Mukherjee/PHI REFERENCES:
3. Beyond TQM / Robert L.Flood
4. Statistical Quality Control / E.L. Grant / McGraw Hill.
5. Total Quality Management- A Practical Approach/H. Lal
6. Quality Management/Kanishka Bedi/Oxford University Press/2011
7. Total Engineering Quality Management/Sunil Sharma/Macmillan

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COURSE STRUCTURE & SYLLABUS

I Year II Semester	MECHATRONICS (PROGRAM ELECTIVE-4) (25AM1D13)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1. To impart the basic knowledge and importance on Mechatronics in Engineering Fields among the students.
2. To create the awareness on Mechatronics in Research and Application area.
3. To impart the knowledge about the application and utility of Mechatronics used in various sectors and fields.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

CO1 Identification and demonstration of key elements of mechatronics system and its representation in terms of block diagram (K2).

CO2 Describe the use of solid-state electronic devices, diodes, amplifiers, etc. in designing the mechatronics systems and MEMS (K2).

CO3 Illustrate the applications of various hydraulic, pneumatic, mechanical, electrical actuating systems and valves in designing the mechatronic systems (K3).

CO4 Develop the PLC ladder programming for the creation of real-time mechatronic system (K6).

CO5 Develop dynamic models using system interfacing and data acquisition methods to design mechatronics systems for future applications (K6)

UNIT – I:

Mechatronics systems, elements, levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

UNIT – II:

Solid state electronic devices, P-N junction diode, BJT, FET, DIA and TRIAC. Analog signal conditioning, amplifiers, filtering. Introduction to MEMS & typical applications.

UNIT – III:

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Hydraulic and pneumatic actuating systems, Fluid systems, Hydraulic and pneumatic systems, components, control valves, electro-pneumatic, hydro pneumatic, electro-hydraulic servo systems, Mechanical actuating systems and electrical actuating systems.

UNIT – IV:

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

UNIT – V:

System and interfacing and data acquisition, DAQS, SCADA, Analogue to Digital and Digital to Analogue conversions; Dynamic models and analogies, System response. Design of mechatronics systems & future trends. Modeling and analysis of mechatronics systems (case studies)

TEXTBOOKS:

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran & GK VijayaRaghavan/WILEY India Edition/2008.
2. Mechatronics Electronics Control Systems in Mechanical and Electrical Engineering by W Bolton, Pearson Education Press, 3rd edition, 2005.

REFERENCE BOOKS:

1. Mechatronics Source Book by Newton C Braga, Thomson Publications, Chennai.
2. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
3. Mechatronics System Design / Devdasshetty / Richard / Thomson.
4. Mechatronics / M.D. Singh / J.G. Joshi/PHI.
5. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition, Pearson, 2012 W. Bolton.
6. Mechatronics – Principles and Application Godfrey C. Onwubolu, Wlsevier, 2006 Indian print.

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.

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COURSE STRUCTURE & SYLLABUS

I Year II Semester	THEORY OF PLASICITY (PROGRAM ELECTIVE-4) (25AM1D14)	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce fundamental concepts of plasticity, including stress tensors, yield criteria, and strain-displacement relationships in materials under load.
2. To explain the principles of virtual work, stability postulates, and flow rules governing elastic-plastic behavior in materials.
3. To discuss incremental stress-strain relations and deformation theories applicable to plastic materials with hardening behavior.
4. To provide an understanding of finite element methods for elastic-plastic analysis and numerical techniques for solving nonlinear problems.
5. To study advanced topics like bounding surface theory, anisotropic plasticity, and theorems of limit analysis for complex loading conditions.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

CO No.	Course Outcome	Bloom's Level
CO1	Understand and explain the fundamental stress-strain relations and yield criteria in plastic materials.	Understand
CO2	Apply virtual work principles, stability postulates, and flow rules to analyze elastic-plastic material behavior.	Apply
CO3	Analyze and solve problems using incremental stress-strain relationships and deformation theories of plasticity.	Analyze
CO4	Implement finite element formulations and numerical methods to solve elastic-plastic problems in materials.	Apply / Analyze
CO5	Evaluate anisotropic plasticity and apply limit analysis theorems to determine safe load-carrying capacities of bodies.	Evaluate

UNIT – 1

Introduction: Modeling Uniaxial behavior in plasticity. Index notation, Cartesian tensors. Yield and failure criteria Stress, stress deviator tensors. Invariants, principal, mean stresses, Elastic

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strain energy, Mohr's representation of stress in 2 & 3 dimensions, Haigh-Westergaard stress space, Equilibrium equations of a body. Yield criteria: Tresca's, von Mises rules, Drucker-Prager criterion, anisotropic yield criteria. Strain at point: Cauchy's formulae for strains, principal strains, and principal shear strains, derivative strain tensor. Strain-displacement relationships. Linear elastic stress strain relations, Generalized Hooke's law, nonlinear elastic stress strain relations

UNIT – 2

Principle of virtual work and its rate forms: Drucker's stability postulate, normality, convexity and uniqueness for an elastic solid. Incremental stress strain relations. Criteria for loading and unloading: Elastic and plastic strain increment tensors, Plastic potential and flow rule associated with different Yield criteria, Convexity, normality and uniqueness considerations for elastic–plastic materials. Expansion of a thick walled cylinder.

UNIT – 3

Incremental stress strain relationships: Prandtl-Reuss material model. J2 deformation theory, Drucker-Prager material, General Isotropic materials. Deformation theory of plasticity: Loading surface, Hardening rules. Flow rule and Druckers stability postulate. Concept of effective stress and effective strain, mixed hardening material. Problems.

UNIT – 4

Finite element formulation for an elastic plastic matrix: Numerical algorithms for solving non linear equations, Convergence criteria, Numerical implementations of the elastic plastic incremental constitutive relations

UNIT – 5

Bounding surface theory: Uniaxial and multiaxial loading anisotropic material behavior Theroms of limit analysis: Statically admissible stress field and kinematically admissible velocity field. Upper and lower bound theorems, examples and problems.

TEXT BOOK:

1. Theory of Elasticity by S.P. Timoshenko & J.K Goodier, MGH

REFERENCES:

1. Plasticity for structural engineering W.F.Chen s and D.J.Han, Springer verlag-1987.
2. Mechanics of Materials –II, Victor E. Saouma.
3. Theory of plasticity, Sadhu Singh

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COURSE STRUCTURE & SYLLABUS

I Year II Semester	DESIGN AND ANALYSIS OF EXPERIMENTS (Program Elective 4) (25AM1D15)	L	T	P	C
		3	0	0	3

Course Objectives

1. Understand the fundamental concepts and assumptions of Analysis of Variance (ANOVA) in one-way and two-way classifications.
2. Apply principles of experimental designs including Completely Randomized Design (CRD), Randomized Block Design (RBD), and Latin Square Design (LSD) to practical problems.
3. Analyze the role of blocking and layout strategies in reducing experimental errors and improving data accuracy.
4. Evaluate main and interaction effects in factorial experiments such as 2^2 and 2^3 designs using statistical methods.
5. Use statistical software tools (Excel, MS Word) to process experimental data and effectively communicate results.

Course Outcomes (Cos)

1. Demonstrate the ability to perform ANOVA for one-way and two-way classifications on experimental data (K3).
2. Design experiments using CRD, RBD, and LSD layouts and interpret critical differences to control variability (K4&K5).
3. Handle missing data in experimental designs and perform appropriate statistical adjustments and analyses (K4&K5).
4. Analyze factorial experiment data to determine main and interaction effects using Yates procedure and related methods (K4).
5. Prepare comprehensive reports and present findings from experimental data using spreadsheet tools and documentation software (K5&K6).

Unit – 1:

Analysis of variance (ANOVA) Concept, Definition and assumptions. ANOVA one way classification – mathematical model, analysis – with equal and unequal classification. ANOVA two way classification – mathematical model, analysis and problems.

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Unit – 2:

Completely Randomised Design (CRD) Definition, terminology, Principles of design of experiments, CRD – Concept, advantages and disadvantages, applications, Layout, Statistical analysis. Critical Differences when hypothesis is significant.

Unit – 3:

Randomised Block Design (RBD) Concept, advantages and disadvantages, applications, Layout, Statistical analysis and Critical Differences. Efficiency of RBD relative to CRD. RBD with one missing value and its analysis, problems.

Unit – 4:

Latin Square Design Concept, advantages and disadvantages, applications, Layout, Statistical analysis and Critical Differences. Efficiency of LSD over RBD and CRD. Estimation of one missing value in LSD and its analysis, problems.

Unit – 5:

Factorial experiments Main effects and interaction effects of 2^2 and 2^3 factorial experiments and their Statistical analysis. Yates procedure to find factorial effect totals.

Practical Syllabus

1. ANOVA - one - way classification with equal number of observations.
2. ANOVA - one - way classification with unequal number of observations.
3. ANOVA Two-way classification.
4. Analysis of CRD and critical differences.
5. Analysis of RBD and critical differences. Relative efficiency of CRD with RBD.
6. Estimation of single missing observation in RBD and its analysis.
7. Analysis of LSD and efficiency of LSD over CRD and RBD.
8. Estimation of single missing observation in LSD and its analysis.
9. Analysis of 2^2 with RBD layout.
10. Analysis of 2^3 with RBD layout.

Note: Training shall be on establishing formulae in Excel cells and derive the results. The excel output shall be exported to MS word for writing inference.

References

1. S. C. Gupta & V. K. Kapoor: Fundamentals of Applied Statistics, Sultan Chand &Sons, New Delhi.

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2. K.V.S. Sarma: Statistics Made Simple: Do it yourself on PC. PHI.
3. M. R. Saluja: Indian Official Statistics. ISI publications.

Suggested Co-curricular Activities:

1. Training of students by related industrial experts
2. Assignments including technical assignments if any.
3. Seminars, Group Discussions, Quiz, Debates etc on related topics.
4. Preparation of audio and videos on tools of diagrammatic and graphical representations.
5. Collection of material/figures/photos/author photoes of related topics.
6. Invited lectures and presentations of stalwarts to those topics.
7. Visits/field trips of firms, research organizations etc.

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COURSE STRUCTURE & SYLLABUS

I Year II Semester	GREEN MANUFACTURING (Program Elective 4) (25AM1D16)	L	T	P	C
		3	0	0	3

Course Objectives

1. To introduce the concepts, motivations, and challenges associated with Green Manufacturing and its environmental, social, and policy impacts.
2. To familiarize students with metrics and methodologies used to measure and evaluate green manufacturing processes and supply chains.
3. To explore closed-loop production systems, including lifecycle assessment, sustainable factory design, and eco-efficient manufacturing processes.
4. To study the environmental implications of advanced technologies like nano-manufacturing and the role of clean energy in green manufacturing.
5. To analyze the role of sustainable packaging and supply chain practices in minimizing environmental footprints.

Course Outcomes (COs)

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

CO No.	Course Outcome	Bloom's Level
CO1	Explain the principles, motivations, and barriers of green manufacturing within social, business, and policy contexts.	Understand
CO2	Apply various green manufacturing metrics and life cycle assessment methodologies to evaluate manufacturing processes.	Apply
CO3	Analyze and design closed-loop production systems for economic and ecological sustainability.	Analyze
CO4	Assess the environmental impacts of nano-manufacturing technologies and propose clean energy solutions for manufacturing.	Evaluate
CO5	Evaluate packaging and supply chain strategies to enhance sustainability and reduce environmental impact.	Evaluate

Unit – 1:

Introduction to Green Manufacturing, Why Green Manufacturing, Motivations and Barriers to

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Green Manufacturing, Environmental Impact of Manufacturing, Strategies for Green Manufacturing. The Social, Business, and Policy Environment for Green Manufacturing: Introduction, The Social Environment—Present Atmosphere and Challenges for Green Manufacturing, The Business Environment: Present Atmosphere and Challenges, The Policy Environment—Present Atmosphere and Challenges for Green Manufacturing.

Unit – 2:

Metrics for Green Manufacturing Introduction, Overview of Currently Used Metrics, Overview of LCA Methodologies, Metrics Development Methodologies, Outlook and Research Needs. Green Supply Chain: Motivation and Introduction, Definition, Issues in Green Supply Chains (GSC), Techniques/Methods of Green Supply Chain, Future of Green Supply Chain. Principles of Green Manufacturing: Introduction, Background, and Technology Wedge Principles Mapping Five Principles to Other Methods and Solutions.

Unit – 3:

Closed-Loop Production Systems Life Cycle of Production Systems, Economic and Ecological Benefits of Closed Loop Systems, Machine Tools and Energy Consumption, LCA of Machine Tools, Process Parameter Optimization, Dry Machining and Minimum Quantity Lubrication, Remanufacturing, Reuse, Approaches for Sustainable Factory Design.

Unit – 4:

Environmental Implications of Nano-manufacturing Introduction, Nano-manufacturing Technologies, Conventional Environmental Impact of Nano manufacturing, Unconventional Environmental Impacts of Nano-manufacturing, Life Cycle Assessment (LCA) of Nanotechnologies. Green Manufacturing Through Clean Energy Supply: Introduction, Clean Energy Technologies, Application Potential of Clean Energy Supplying Green Manufacturing

Unit – 5:

Packaging and the Supply Chain A Look at Transportation, Introduction, Background, Recommended Method to Determine Opportunities for Improved Pallet Utilization, Discussion.

Text Book:

1. David Dornfeld "Green Manufacturing Fundamentals and Applications", Springer, 2013
2. Reference:
3. J. Paulo Davim "Green Manufacturing Processes and Systems" Springer-Verlag Berlin Heidelberg, 2013

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I Year II Semester	MATERIAL CHARACTERIZATION LAB (25AM2L03)	L	T	P	C
		0	1	2	2

Course Objectives

1. To introduce various microscopy techniques and their applications in material characterization, focusing on imaging theory, resolution, and magnification.
2. To provide hands-on experience in optical microscopy for microstructural analysis including grain size and phase percentage estimation.
3. To develop skills in evaluating mechanical properties such as hardness, tensile strength, compression strength, and flexural strength of metals.
4. To expose students to non-destructive testing methods like dye penetrant and magnetic particle inspection for detecting surface defects.
5. To familiarize students with advanced characterization techniques such as XRD, FESEM, and digital scanning calorimetry for material analysis.

Course Outcomes (COs)

Upon successful completion of this lab, students will be able to:

CO No.	Course Outcome	Bloom's Level
CO1	Demonstrate knowledge of different microscopy techniques and apply optical microscopy to analyze microstructures.	Understand & Apply
CO2	Perform micro hardness testing and mechanical property evaluation (tensile, compression, and flexural) on metals.	Apply
CO3	Conduct and interpret non-destructive tests such as dye penetrant and magnetic particle inspection.	Apply & Analyze
CO4	Evaluate tribological properties of ferrous and non-ferrous materials using pin-on-disc testing.	Analyze
CO5	Interpret XRD, FESEM, and DSC images/data for advanced material characterization.	Analyze & Evaluate

1. Microscopy: Different microscopy techniques, Resolution, Magnification, Depth of field

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Imaging – theory and concepts.

2. Optical Microscopy: Grain size estimation, Phase Percentage Estimation
3. Micro hardness evaluation of Ferrous and Non ferrous metals.
4. Testing of Tensile Properties of mild steel material
5. Testing of Compression Properties
6. Testing of Flexural Strength on Ferrous metals.
7. Die penetrant test
8. Magnetic particle Inspection
9. Evaluation of Tribological properties of Ferrous and Non ferrous metals through Pin on Disc Tester.
10. Study of XRD Analysis
11. Study of FESEM Images
12. Study of digital scanning calorimetry images

	online	online	online	online	
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COURSE STRUCTURE & SYLLABUS

I Year II Semester	FINITE ELEMENT SIMULATION OF MANUFACTURING PROCESSES LAB (25AM2L04)	L	T	P	C
		0	1	2	2

Course Objectives

1. To provide students with practical knowledge of modeling various manufacturing processes using Finite Element Analysis (FEA) tools.
2. To develop skills in simulating casting processes, focusing on solidification, temperature distribution, residual stresses, and defect prediction.
3. To enable students to analyze forging processes including cold and hot working, and study material flow, deformation, and defects.
4. To familiarize students with the simulation of forming processes such as blanking, bending, and deep drawing, identifying typical process defects.
5. To introduce the simulation of welding processes including arc, spot, and laser welding, and analysis of associated thermal and mechanical defects.

Course Outcomes (COs)

Upon successful completion of this lab, students will be able to:

CO No.	Course Outcome	Bloom's Level
CO1	Develop finite element models for casting processes and analyze solidification, temperature, and residual stress patterns.	Apply & Analyze
CO2	Simulate forging processes (cold and hot working) and assess material deformation and potential defects.	Apply & Evaluate
CO3	Model forming processes such as blanking, bending, and deep drawing to predict process behavior and defects.	Apply & Analyze
CO4	Conduct finite element simulations of welding processes and analyze thermal cycles and defect formation.	Apply & Analyze
CO5	Interpret simulation results to optimize manufacturing processes and minimize defects.	Analyze & Evaluate

	online	online	online	online	
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Member-Affiliating Univ. Nominee	Subject Expert	Subject Expert	Industry Expert	PG Alumni	Chair-person BOS

Students shall carry out the modeling and FE analysis of the following:

1. Casting processes - Study of Solidification, temperatures, Residual stresses, metallurgical phases, defects, etc.
2. Forging processes - Study of cold working and hot working processes for extrusion, drawing, rolling, defects, etc.
3. Forming Processes – Study of blanking, bending, deep drawing, defects, etc.
4. Welding Processes – Study of arc, spot, laser welding, defects, etc.

	online	online	online	online	
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COURSE STRUCTURE & SYLLABUS

I Year II Semester	SEMINAR II (25AM2S02)	L	T	P	C
		0	0	2	1

	online	online	online	online	Naveen
Dr. M. Kumara Swamy Assoc. Professor, Dept. of ME, UCEK (A), JNTUK	Dr. M. Ravi Sankar Prof. & Head, Dept. of ME, IITTP	Dr. T. Babu Rao, Asst. Professor, Dept. of ME, NITAP	Mr. K. M. Dakshina Murty, Sr. DGM, BHEL-HYD	Mr. U. Srinivas Technical officer C, ISRO-SHAR, Sriharikota	Dr. M. Naveen Srinivas, HOD-ME, BVCE(A)
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II Year I Semester	RESEARCH METHODOLOGY AND IPR (25HM3D01)	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

1.To understand the knowledge on basics of research and its types.
2.To impart the concept of Literature Review, Technical Reading, Attributions and Citations.
3.To know the Ethics in Engineering Research.
4.To know the concepts of Intellectual Property Rights in Engineering.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:
CO1 Explain the meaning of engineering research and apply to develop an appropriate framework for research studies (K2&K3).
CO2 Identify the procedure of Literature Review, Technical Reading, etc. and apply to develop a research design during their project work (K2&K3).
CO3 Explain and apply the fundamentals of patent laws and drafting procedure in their research works (K2&K3).
CO4 Demonstrate the copyright laws, subject matters of copyrights, designs etc. to apply in patent filing (K2&K3).
CO5 Identify the new developments in IPR and employ the applications of computer software in writing/filing patents in future (K6).

UNIT – I:

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

UNIT – II:

Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

	online	online	online	online	
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UNIT – III:

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT – IV:

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

UNIT – V:

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR.

TEXTBOOKS:

1. C.R. Kothari , 2nd Edition, "Research Methodology: Methods and Techniques".
2. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step-by-Step Guide for beginners"

REFERENCE BOOKS:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction".
3. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
4. Mayall, "Industrial Design", McGraw Hill, 1992.
5. Niebel, "Product Design", McGraw Hill, 1974.
6. Asimov, "Introduction to Design", Prentice Hall, 1962.
7. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
8. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

WEB REFERENCES:

- Please include hyperlinks related to NPTEL/VLabs etc.

	online	online	online	online	
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II Year I Semester	SUMMER INTERNSHIP (25AM3P01)	L	T	P	C
		0	0	0	3

COURSE OBJECTIVES:

1. Internships provide students with an opportunity to put into practice skills they have learned while in college.
2. In addition, students should have an opportunity to enhance those skills, obtain the perspective of a work environment and benefit from a mentor or supervisor's experience and advice.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

CO1 Integrate theory and practice to assess interests and abilities in their field of study (K3&K4).

CO2 Develop work habits, attitudes necessary to appreciate work and its function in the economy (K3).

CO3 Develop communication, interpersonal and other critical skills to build a record of work experience (K3).

Based on suggested Revised Blooms Taxonomy Level (BTL) K1: Remember K2: Understand K4: Analyse K5: Evaluate, K6: Create

	online	online	online	online	
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II Year I Semester	COMPREHENSIVE VIVA (25AM3V01)	L	T	P	C
		0	0	0	2

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II Year I Semester	DISSERTATION PART A (25AM3P02)	L	T	P	C
		0	0	20	10

COURSE OBJECTIVES:

1. To impart fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study.
2. To familiarise how to incorporate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.
3. Expose to the critical aspects like identifying, analysing and solving problems creatively through sustained critical investigation using effective oral, written and visual communications.
4. To inculcate the key aspects like awareness and application of appropriate personal, societal and professional ethical standards to excellence needed to engage in lifelong learning.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

CO1 Carryout a critical review of literature on a chosen topic of research and identify gaps in the literature to define a problem for research work (K3&K4).

CO2 Formulate/adapt a clear methodology using multi-disciplinary approach and modern tools (K3&K6).

	online	online	online	online	
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COURSE STRUCTURE & SYLLABUS

II Year II Semester	DISSERTATION PART B (25AM4P03)	L	T	P	C
		0	0	32	16

COURSE OBJECTIVES:

1. To impart fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study.
2. To familiarise how to incorporate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.
3. Expose to the critical aspects like identifying, analysing and solving problems creatively through sustained critical investigation using effective oral, written and visual communications.
4. To inculcate the key aspects like awareness and application of appropriate personal, societal and professional ethical standardsto excellence needed to engage in lifelong learning.

COURSE OUTCOMES:

Upon successful completion of this course, the student will be able to:

CO1 Carryout design/analysis of a product/system or devise experiments to study and develop a system/process/product (K3&K4).

CO2 Interpret & validate results of analysis/experiments conducted to study behaviour of a product /system/ process considered for the research leading to valid conclusions that add value to the body of knowledge (K3&K5).

CO3 Write and present a technical report of the project work (K6).

Based on suggested Revised Blooms Taxonomy Level (BTL) K1: Remember K2: Understand K4: Analyse K5: Evaluate K6: Create

	online	online	online	online	
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