# ME (PRODUCTION ENGINEERING)

## First Semester

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### List of Electives

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**Total Number of Credits: 63.0**
PCD103 MECHATRONICS

Prerequisite(s): None

Course Objectives: To impart interdisciplinary knowledge to study modern products like household appliances, Digital Cameras, Mobiles etc. The aim of this course to make a bridge between Mechanical, Electronics, Instrumentation, Computer and Controls field.

Introduction: Integration of Mechanical Engineering, Electronics & control engineering and computer science, Elements of mechatronics system, Open system and closed system.


Control Systems: Laplace transformations, Block diagram reduction, Signal flow graph, performance specifications, Transfer functions, Stability, Types of controller, Controller design using frequency domain and Laplace domain methods, Digital control, Z-transforms, State space control, Regulation problem, Tracking problems, Pole placement approach

Sensors: Displacement, Position and proximity sensors, Flow sensors, Pressure and force sensors, Motion sensors, Optical, Mechanical and thermal sensors.

Actuators in mechatronics system: Electric actuators, Stepper motors, DC motors, and AC motors, their types and control, Hydraulic actuators and pneumatic actuators, Types and control, Piezoelectric actuators

Electronic Elements in Mechatronic System: Analog to digital and digital to analog converters, Operational amplifiers, Microcontrollers, Microprocessors, Logic circuit devices and gates.

Course Outcomes:
The students will be able to
- understand the basic elements of any Mechatronic device.
- develop the mathematical model of any physical model from any engineering domain.
- understand the key inputs and outputs of any physical device, different sensors and transducers to measure the outputs, interfacing of the sensors and actuators to the computers.
- study and design different controllers to obtain the desired performance from the system.

Recommended Books:
PCD105 COMPUTER AIDED MANUFACTURING

Prerequisite(s): None

Course Objectives: To Introduce the students to the basic standard terminologies/ conventions, hardware, applications, merits and demerits of general NC, CNC, DNC technology. To expose the students to Automatic/ Computer Assisted NC tool path programming using professional software tools used for complicated machining applications.

Introduction: Fundamental concepts in numerical control, Need of N.C. in machines tools, Its advantages, Structure of NC System.

Part Programming: Block format and codes, Tool length and radius compensation, Flexible tooling, Tool path simulation on lathe and milling, Advanced programming features, Tooling For N. C. Machines: Tool and zero presetting, Work holding and setting up of CNC machine.

N.C. Machine Tools: Types, Definition and designation of control axes, Constructional details of N. C. m/c tools, MCU structure and functions, Methods of improving accuracy and productivity using NC, Problems with conventional NC.

Numerical Control of M/c Tools: NC, Functioning of NC, MCU Organization, CNC, DNC, Adaptive control types, Uses & benefits, Advantages of CNC, DNC their structure, Combined CNC/DNC systems.

System Devices: Drives, Feedback devices, Counting devices, DAC and ADCs, Interpolator systems, Control loop circuit elements in PTP system, Contouring system, Incremental and absolute systems.

Computer Assisted Part Programming: Automatic NC program generation from CAD models; The APT language, Machining of surfaces, Mould, Casting and Die design and manufacture using CAD/CAM software.

Laboratory Work

Exercises in manual part programming for turning and milling centers, Use of software for simulation of turned and milled parts and simple surfaces, Automatic Cutter location data generation from CAD Models in APT format and Post processing for machining on CNC machines. Mould, Casting and Die design and manufacture using CAD/CAM software.

Course Outcomes:
The students will be able to:
- work individually and/or with an interdisciplinary team for the purpose of selection, design and use of NC technology for manufacturing applications.
- generate manual/automated part programs for a given part to be machined on NC/CNC system.
- understand, create and demonstrate the technical reports for manufacturing automation as well as with regard to NC machining.

Recommended Books

Approved by the Senate in its 83rd meeting held on March 3, 2014
6. Manuals of CAD/CAM Software Package on CAM Module and CNC Machines.
Prerequisite(s): None

Course Objectives: Exposure to CAD tools for use in mechanical engineering design conceptualization, geometric modelling, communication, analysis and optimization, further use in CAD, CAM, CAE related courses and research work. Impart knowledge related to principles, methods and techniques of 3D modelling in parametric CAD software. Undertake project works in use of CAD geometric modeling software for design analysis, evaluation and optimization using a professional software.

CAD Overview: Introduction to use of computer in Product Life Cycle, Software for mechanical engineering CAD/CAM/CAE.

Geometric Modeling: Parametric sketching, Constrained model dimensioning, Material addition and removal for extruded, Revolved, Swept and blended features, References and construction features of points, Axis, Curves, Planes, Surfaces and customized analysis features, Feature and sequence of feature editing. Cosmetic features, Chamfers, Rounds, Standard holes, File formats for data transfer. Feature patterns, Duplication, Grouping, Suppression, Assembly modeling, Assembly analysis tools. Top-down vs. bottom-up design, Parametric relations and design optimization parameters creation, Mass property analysis, Automatic production drawing creation and detailing, Software automation and customization tools, Colors and rendering, Advanced features for non parallel blend, Helical sweep, Swept blend, Variable section sweep, Draft, Ribs, Sketched holes, Mechanism design and assembly, Customized design & CAD automation using user defined features UDF.

Mechanical Design Analysis and Optimization: Design analysis for mass properties, Stress, Thermal stress, Fatigue, Fluid flow, etc using CAD/CAE packages, Optimum design of machine components using multivariable non linear optimization techniques using iterative CAD/CAE software tools.

Laboratory Work:

Use of standard CAD and CAE packages for modeling of mechanical elements, Assembly and Automated Drawing. Introduction to Surfacing, Sheet metal, Assembly analysis, Mechanism design and motion analysis, Projects involving assembly and kinematic analysis of mechanisms, Optimization of mechanical system design using CAD/CAE software tools, Projects on mechanical systems design and analysis.

Course Outcomes: Students will be able to
- use parametric CAD software for geometric modeling of mechanical designs.
- translate production drawings to 3D CAD models.
- evaluate a mechanical design and optimize it using CAD, CAE software.
- use 2D / 3D CAD and CAE for use in other courses and research thesis work.

Recommended Books
1. Manuals & Tutorials on CAD/CAE packages like Pro/Engineer, Pro/Mechanica, ANSYS, etc latest available in the lab.

Approved by the Senate in its 83rd meeting held on March 3, 2014.
PCD313 MACHINE TOOL DESIGN

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Prerequisite(s): None

Course Objectives: To explore various design aspects of machine tools elements like transmissions, structures, materials, kinematics, dynamics and construction of machine tools, etc. To understand concepts related to design of Die and Punch.

Introduction: General requirement of machine tool design, Techno-economic pre-requisites.


Jigs and Fixtures Design: Applications in manufacturing, principle of location & clamping, types of locators and clamps, Design of jigs and fixtures, selection of materials.

Die and Punch Design: Applications in manufacturing, Design of various type of dies, selection of materials for casting and forging dies.

Course Outcomes: At the end of the course the students will be able to:
- develop the conceptual design, manufacturing framework and systematic analysis of design problems on the machine tools
- apply the design procedures for different types of design problems such as gear box design, guide way design, shaft loading and its associated parts, rolling bearings, die design and jigs and fixtures and so on.
- design, develop, and evaluate cutting tools and work holders for a manufactured product.

Recommended Books
PPI201 ADVANCED MANUFACTURING PROCESSES

L T P Cr
3 1 2 4.5

Prerequisite(s): None

Course Objectives: To impart knowledge about principles/methods of different non-traditional manufacturing processes and analytical/mathematical approach to quantify amount of material removal and of these processes. To impart knowledge about the role of controlling process parameters and selection of different process parameters for optimal performance for different engineering materials.

Non Traditional Manufacturing Processes: Development and classification, Considerations in processes selection. Mechanics of material removal, Tool design, Effect of process parameters on MRR, Accuracy, Surface finish and applications of the various non-conventional machining processes like; Ultrasonic machining (USM), Abrasive jet machining (AJM), Water jet machining (WJM), Electro chemical machining (ECM), Electro chemical grinding (ECG), Chemical machining (CHM), Electric discharge machining (EDM), Electron beam machining (EBM), Plasma arc machining (PAM), Laser beam machining (LBM) and Ion beam machining (IBM) processes.


Laboratory Work

Calculations of MRR, TWR for USM, EDM, LBM, PAM Processes, Use of dynamometer, Surface finish measurement tests.

Course Outcomes:
The students will be able to
- Understand the mechanics of material removal in different nontraditional machining processes and forming behavior during high energy rate forming processes.
- Analyze the process and evaluate the process performance in each process role of each process parameters on performance of the process during machining of different materials.
- Role, selection and application of process in nonconventional machining and forming processes based on different requirement.

Recommended Books
PCD325 RAPID PROTOTYPING

Prerequisite(s): None

Course Objectives: To explore the automatic fabrication of 3D physical parts using additive manufacturing technology. To use of additive manufacturing for rapid prototyping takes designs from computer aided design (CAD), tessellates them in RP software and then build the actual physical 3D models in an additive manner layer-by-layer.


Classifications of Different RP Techniques: Based on raw material, Based on layering technique (2D or 3D) and energy sources.

Process Technology in RP: Comparative study of stereo-lithography (SL) with photo-polymerization, SL with liquid thermal polymerization, Selective laser sintering, Selective powder binding, Ballistic particle manufacturing, both 2D and 3D, Fused deposition modeling, Shape melting, Laminated object manufacturing, Solid ground curing, Repetitive masking and deposition, Beam inference solidification, Holographic interference Solidification, Special topic on RP using metallic alloys, Programming in RP, Modelling, Slicing, Internal hatching, Surface skin fills, Support structure.

CAD Data and Programming Techniques for RP: Data requirements, Solid modeling for RP, Surface modeling, Geometric processes, Interface formats, Model preparation, Slicing methods, Design of support structures, Internal hatching and surface skin fills.


Course Outcomes:
The students will be able to
• understand the importance of Rapid Prototyping Technology over the existing traditional methods in present competitive scenario in terms of product development cycle and cost,
• understand the insight into various modern rapid prototyping techniques, how the different processes work, how they have developed, applications, material used and strengths as well as weaknesses of each technology.

Recommended Books
PPI 204 OPERATIONS MANAGEMENT

Prerequisite(s): None

Course Objectives: The objective of this course is to develop understanding of the strategic role of operations management in creating and enhancing a firm’s competitive advantages. This will help to apply key concepts and issues of OM in both manufacturing and service organizations. Further, apply analytical skills and problem-solving tools to the analysis of the operations problems like forecast demand, Material Requirement Planning, Inventory etc.

Production Systems: Production/Operations Management: meaning and scope; significance of operations management in increasing productivity of firms; design of different production systems (project, job shop, batch, cellular, mass production systems).

Forecasting Analysis: Need, benefits and applications, cost and accuracy of forecasting, factors affecting demand, types of forecast based on methodology, types of forecast based on time horizon (causal methods, time series and qualitative methods); error analysis in quantitative forecasting.

Aggregate Planning: Need of aggregate production planning, inputs for aggregate plan, Reactive aggregate planning strategies, Aggressive aggregate planning strategies, pure and mixed aggregate planning strategies, level and chase strategies, Graphical method to choose aggregate plan.

Master Production Scheduling and MRP: Functions, planning horizon and planning periods for master production schedule, types of master production schedule; Independent Demand versus dependent demand, Functions of material requirements planning and manufacturing resource planning (MRP I and MRP II), inputs for MRP system, performance characteristics of MRP system (planning lead time, lot sizing rules, safety stocks), materials requirement planning explosion

Inventory Management and Control: Objectives and functions of materials management, inventory: need and types, inventory record systems, inventory costs and order quantities, economic order quantity, economic run length.

Course Outcomes: The students will be able to

- Deeply understand the fundamental theory of operations and production management.
- Solve various kinds of problems or issue faced by service and manufacturing industries like economic consideration, optimum utilization of resources, productivity, production planning, inventory management and control etc.

Recommended Books

PPI103 QUALITY ENGINEERING

Prerequisite(s): None

Course Objectives: To impart knowledge about the significance of quality and the various tools/ concepts of building quality into products. To learn the techniques used for quality control and quality improvement. To impart knowledge about plans for acceptance sampling and quality systems.

Introduction: Quality - meaning and significance, Essential components of quality, Phases or elements for building quality, Evolution of the concepts of quality, Spiral of progress of quality, Changing scope of quality activities, Ishikawa’s seven quality tools, Quality Circles, Quality system economics, Hidden quality costs, Economic models of quality costs.

Taguchi’s Quality Loss Function: System approach for quality management, Juran’s quality trilogy, Quality planning activities, Sporadic and chronic quality problems, Causes of variation, General quality control methodology.


Acceptance Sampling: Plans and tables for attributes and variables, Sampling methods, Type of plans, Operating characteristic curves, Quality improvement methodology, Just-in-time philosophy, Quality assurance systems.

ISO 9000 Philosophy: Documentation, Implementation and certification process, Management commitment to quality, Team work approach, Training and motivation.

Course Outcomes:
The students will be able to
- Appreciate the importance of product quality and use various quality tools.
- Prepare and analyze various charts/ methods for quality control and improvement.
- Understand and use plans for sampling and concepts of quality system management.

Recommended Books
PPI312 METAL CASTING AND JOINING

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Prerequisite(s): None

Course Objectives: To inculcate the principle, thermal and metallurgical aspects during solidification of metal and alloys. To impart knowledge about principles/methods of casting with detail design of gating/riser system needed for casting, defects in cast objects and requirements for achieving sound casting. To impart knowledge about welding behaviour of machine and process during welding, analysis of common and newer welding techniques and metallurgical and weldability aspects of different common engineering materials.

Casting Technology & problems, Survey and scope, Interfacial Heat Transfer, Thermodynamics & metallurgical aspects in solidification of pure metals and alloys, Solidification of actual castings, Homogeneous and heterogeneous nucleation, Codification for pure metals and alloys. Grain refinement techniques,

Riser Design: Risering curves, NRL, Caine method, Feeding distance, Rising of complex castings, Gating systems and their characteristics. Type of gates and design consideration, Chills pattern design consideration, Sand testing, Advanced metal casting processes, Casting defects, Their causes & redressal, Heat treatment of castings, Heat treatment of castings, Gases in metals.

Metal Joining: Classification – Welding power source, Arc and arc characteristics, Behavior of arc with variation in current and voltage, Welding electrodes, ISI specification of electrodes, Electrode selection, Newer welding process- such as plasma arc, Laser beam, Electorate, Ultrasonic welding, Joining by braking, Soldering and adhesive bonding.

Welding Metallurgy: Heat flow is welding metallurgical transformation, Implication of cooling rate, HAZ, Weldability of plain carbon steels, SS, CI, Al and its alloys, Design of elements, Residual stresses and distorting, Welding defects, Testing-destructive and NDT.

Course Outcomes:
The students will be able to
- Analyze the thermal, metallurgical aspects during solidification in casting and welding and their role on quality of cast or weld objects.
- Design the gating and riser system needed for casting and requirements to achieve defect free casting.
- Analyze the welding process behavior for common and newer welding techniques and requirements to achieve sound welded joint while welding different similar and dissimilar engineering materials.

Recommended Books
Prerequisite(s):  None

Course Objectives: To impart knowledge about principles and criteria of yielding during forming of metals, analysis of different bulk and sheet metal forming processes following different analysis approach. To understand the process mechanics with role of different controlling process parameters.


Rolling and Drawing Mechanics: Rolling pressure, Driving torque and power requirements through frictionless dies. Metal drawing, Die design, Analysis of tube drawing process, Defects in drawn components.

Forging Processes and Mechanics: Determination of forces in strip forging and disc forging, Defects, Forging die design.

Bending and Extrusion: Process, Parameters and determination of workload from stress analysis and energy, Drawing and extension of strip through tapered dies considerations, Power loss variables, Extrusion and bending defects. Two-dimensional deformation model and fracture analysis for punching and blanking, Theory of high energy rate forming.

Course Outcomes:
The students will be able to
- Understand the basic mechanics of yielding and yield criteria.
- Analyze the different bulk and sheet metal forming process mechanics using different analysis approach.
- Evaluate the effect of process parameters on the process mechanics during bulk and sheet metal forming.

Recommended Books
Prerequisite(s): None

Course Objectives: To inculcate specialized knowledge and skill in production process optimization using
the principles and methods of engineering analysis and design. To cultivate the ability to build and
implement new improved methods resulting in creation and distribution of value in operations. To cultivate
work space design capability. To develop the skill in systems integration by fostering the ability to work
with inter-disciplinary groups in professional, industry and research organizations.

Introduction to Productivity: Definition of productivity, Productivity and production,
Importance and role of productivity, Factors affecting productivity, Industrial productivity.

Productivity Evaluation, Measurement Approaches: Need for productivity measurement,
Productivity measurement approaches, Total and partial productivity, Productivity measurement
models and their comparisons, Work study and productivity.

Productivity Improvement, Implementation Factors and Techniques: Internal and External,
Productivity analysis – productivity appraisal, Approaches to productivity analysis, Strategy and
structure of productivity improvement, Organizational approaches to productivity improvement,
Productivity improvement and implementation techniques.

Introduction to Work Study: Definition, Scope, Inter-relation between method study and work
measurement, Human aspects, Role in improving plant productivity and safety.

Method Study: Objectives and step-wise procedure for method analysis, Recording & evaluation
techniques, Micro-motion and macro motion study, Therbligs and Simo-charts, Principle of
motion economy, Normal work areas and design of work places, Principles of work design,
Multiple activity chart, Flow process chart, String diagram, Travel charts.

Work Measurement: Work measurement objectives, Techniques & criteria for selection of
technique, Stop watch time study, Systems of performance ratings, Calculation of standard time,
Introduction to allowances, Production study, Work sampling, MTN & Work Factor system,
Standard data usage, Engineered time standard, Predetermined motion time system (PMTS), Job
evaluation & merit rating, Incentive schemes.

Course Outcomes:
The students will be able to
• Address issues related to productivity assessment and improvement.
• Critiquing operations and using systematic approach to improving shop floor operations.
• Use tools for analysis and design of operations.
• Determine time standards and conditions of work.
• Assist in the design of layout of shop floor.
• Pre-emptive assessment and design of methods of operations.
• Develop wage incentive policy.

Reference Books
1. Barnes, R. M., Motion and time study: design and measurement of work, Wiley, (1980), 7th
   ed.
4. Meyers, F. E., Stewart, J. R., Motion and Time Study for Lean Manufacturing, Prentice
PPI323 PRODUCT DESIGN AND DEVELOPMENT

Prerequisite(s): None

Course Objectives: To introduce the objectives of product design and the requirements of a good product design. To expose the students to different design principles like designing for function, production, installation and handling, maintenance, packaging etc. To expose them to the latest CAD/CAM/CAE software for different design and development functions.

The Process of Product Design: Design by evolution, Limitations of evolutionary method in modern design situation, Structure of design process, Morphology of design, Standards of performance, Environmental factors, Creativity techniques in design problem.

Strategies for Search of Design Concepts: Physical realizability, Economic and financial feasibility, Designing for function, Iterative value engineering, Designing for production, Tolerance analysis, Use, Maintenance, Designing for handling and installing, Economics of design, Human factors in design, Optimization of design, Reverse engineering of ergonomic shape designs.

Use of CAD / CAM /CAE: Software for concurrent engineering design. Case studies in design of products for manufacture, Aesthetics, Surface styling and shaping tools in modern CAD software, Exercises in design, Design optimization using automated CAE software, Analysis, Reverse engineering a product using CAD, CAM, CAE, 3D scanner, Reverse engineering and surface design and review software.

Laboratory/ Tutorial Work
Exercises to practice the concepts taught in theory using hardware and software tools available in the laboratory on CAD/CAM/CAE.

Course Outcomes:
The students will be able to
- understand the objectives of product design and the requirements of a good product design.
- use a systematic design process being fully aware of its benefits.
- translate the concepts of economics in design, optimization of design and human factors approach to product design.
- use CAD/CAM /CAE software for Concurrent Engineering design, 3D scanning and reverse engineering of products.

Recommended Books
PCD316 APPLIED OPTIMIZATION IN ENGINEERING DESIGN

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Prerequisite(s): None

Course Objectives: The main objective of this course is to provide the thorough knowledge of formulating an optimization problem, classification of optimization techniques, different solution strategies, and performance criterion. The course will also highlight the basics of evolutionary optimization techniques as compared to classical techniques.


Multi-dimensional Optimization Methods: Optimality Criteria, Unidirectional search, Direct Search methods, Gradient-based methods, Conjugate-direction methods, Quasi-Newton methods.


Course Outcomes:
The students will be able to
- study as well as solve one-dimensional and multi-dimensional optimization problems.
- formulate as well as analyze unconstrained as well as constrained optimization problems.
- develop Analytical and Graphical solutions of LP problems, Simplex Method
- appreciate the concepts of Integer Programming as well as Duality Theory.
- understand the basic concepts of Multi-Objective optimization and Genetic Algorithms.

Recommended Books:
PCD203 COMPUTER INTEGRATED MANUFACTURING SYSTEMS

L   T   P   Cr
3   1   0   3.5

Prerequisite(s): None

Course Objectives: To impart knowledge about the integration of interdisciplinary fields of computer aided design, computer aided manufacturing, automatic identification system, automatic storage & retrieval system, design and analysis of various automatic material handling systems as a whole. To make the students aware about various techniques of reverse engineering, data collection and its availability to automated subsystems.

Introduction: Types of production systems and their automation, CAD/CAM integration. Concept of FMS and CIMS.


CIMS configurations: DNC based factory management and control, Integrated CAD/CAM system and shared database.

Introduction to Rapid Prototyping, and Rapid Tooling: Reverse engineering, Concept of concurrent engineering, Product life cycle management.

Group Technology: Concept and terminology, Part family formation, Classification and coding systems for components, Group technology machine cells.


Computer Aided Production Planning and Control: Inventory control and MRP. Computer aided shop floor control, process monitoring, Computer aided inspection & quality control, Shop floor data collection systems, Shop floor control, Sensors used, Tool management system, Automatic identification systems, Barcode system.


CIM Database and Database Management Systems: Types, Management information system, Manufacturing data preparation.

Course Outcomes: With this course students will be able to
- understand the structure of modern day computer integrated manufacturing system and design to improve the existing manufacturing facility
- effectively participate in the integration of multidisciplinary capabilities and applications of different fields in automation of any existing facility
- improve the shop floor management and data collection system
- understand the importance of product life cycle and product quality

Recommended Books:
5. *Software Manuals for tutorial on reverse engineering and quality control using 3D scanner*- Scan tools, Surface modeling, Die Design, Automated part programming-2, 3, and 5 axis, QUEST, PLM software like Intralink, WindChill, etc. available from the supplier, in laboratory.
PCD204 INDUSTRIAL AUTOMATION

Prerequisite(s): None

Course Objectives: To inculcate the ability to design of hydraulic, pneumatic and electro-pneumatic logic circuits for automating processes in manufacturing, demonstrate problem-solving skills in automation, and safely use the machines in the industries. Also, to explore the use of different sensors, control valves, controllers and actuators for electro-pneumatic & hydraulic circuits.

Introduction to Factory Automation and Integration: Basic Concepts, Types of automation, Automation strategies.  

Design of pneumatic logic circuits for a given time displacement diagram or sequence of operation. Pneumatic safety and remote control circuits and their applications to clamping, Traversing and releasing operations, Automatic transfer systems: Automatic transfer, Feeding and orientation devices.

Automatic transfer machines: Classifications, Analysis of automated transfer lines, Without and with buffer storage, Group technology and flexible manufacturing system.

Assembly automation: Types of assembly systems, Assembly line balancing, Performance and economics of assembly system.

Course Outcomes:
The students will be able to
- understand the benefits and applications of automation in various manufacturing systems.
- design and simulate various logic circuits for different automating processes in manufacturing systems.
- solve the complex industrial problems by different automation approaches

Recommended Books: