Detailed Syllabus Two year Postgraduate Degree Course (M.Tech.) in Production Engineering with specialization in Manufacturing Systems Engineering

SEMESTER-I

1. **Manufacturing Systems & Automation (3-1-0)**

Course Objectives:

The general objectives of the course are to enable the students to

1. Learn principles and strategies of automation in manufacturing systems.
2. To understand flow lines and assembly systems and their mathematical analysis.
3. To understand automated material handling systems and integration of material handling and storage.
4. To understand grouping of similar parts through group technology and developing automated process plans through computer aided process planning.

Module-I

Manufacturing Systems- Components & classifications, Automation in manufacturing systems, principles and strategies, mathematical models, costs. Single-station manufacturing cells.Automated flow lines: Methods or work part transport transfer Mechanical buffer storage control function, design and fabrication consideration.
[10]

Module-II

Analysis of Automated flow lines: General terminology and analysis of transfer lines without and with buffer storage, partial automation, implementation of automated flow lines.Assembly system and line balancing: Assembly process and systems assembly line, line balancing methods, ways of improving line balance, flexible assembly lines. [12]

Module-III

Automated material handling: Types of equipment, functions, analysis and design of material handlingsystems conveyor systems, automated guided vehicle systems.Automated storage systems, automated storage and retrieval systems; work in process storage, interfacinghandling and storage with manufacturing. [10]

Module-IV

Group Technology- Part classification & coding, Computer Aided Process Planning (CAPP) - Retrieval & Generative type process planning system. [08]

Text Book(s):

1. Automation, Production Systems and Computer Integrated Manufacturing- M.P. Groover, PHI.

Reference Book(s):

1. Computer Control of Manufacturing Systems- Y. Coren, McGraw Hill.
2. CAD/CAM/CIM- Radhakrishnan& Subramanian, Wiley Eastern.

Course Outcomes:

At the end of the course the students shall be able to:

1. Design, analyse and optimize automated flow lines and assembly systems.
2. Develop material handling systems industry application.
3. Generate automated process plans for intended products.

2. Computer Aided Design & Manufacturing(3-1-0)

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the fundamentals of computer aided design and manufacturing including the hardware and software involved.
2. To understand the different geometric modeling techniques like solid modeling, surfacemodeling, feature based modeling etc. and to visualize how the components look like before its production.
3. To learn the NC systems, part programming, CNC, DNC and adaptive control.

Module-I

Fundamentals of CAD: The design process, Application of computer for design, automated drafting, creating manufacturing data base, benefits of CAD, Design workstation- graphic terminal, operator input and output devices, Software of graphic system- graphic package, Data Base Structure, Wireframe Model and Solid Model, Graphics standards Modes of graphics operations, User interface, Software modules, Modeling and Viewing. [10]

Module-II

Geometric Modeling: Mathematical representation of curves, Surfaces and solids- Wire frame models, Entities Analytic curves, Synthetic curves, Manipulation, Surface entities, analytic, Synthetic surfaces, Solid entities, Representation, Manipulations. [10]

Module-III

Geometric Transformation- Transformation of geometric models, Mapping, Inverse transformations, Projections of geometric models, Engineering applications. [06]

Module-IV

Numerical Control: Components of NC system, NC procedure, NC co-ordinate system, motion control, applications, NC part programming-manual part programming, computer assisted part programming, ATP language-macro statements, programming with interactive graphics, NC part programming using CAD/CAM. [08]

Computer control in NC: Problems with conventional NC. Controller Technology, CNC, DNC, Adaptive Control. [06]

Text Book(s):

1. CAD/CAM Theory and Practice- I. Zeid, TMH.
2. CAD/CAM-M.P. Groover & E.W. Zimmers, PHI.

Reference Book(s):

1. CAD/CAM/CIM- Radhakrishnan & Subramanyan, Wiley Eastern.
2. Automation, Production System and CIM- M.P. Groover, PHI.

Course Outcomes:

At the end of the course the students shall be able to:

1. Describe the mathematical basis in the technique of representation of geometric entities including points, lines, and parametric curves, surfaces and solid.
2. Apply the technique of transformation of geometric entities using transformation matrix.
3. Write NC Part program for machining in CNC machines

3. Manufacturing System Models (3-1-0)

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the fundamentals of manufacturings systems and management of integrated manufacturing systems.
2. Understand product and process design and optimization of single stage and multistage manufacturing systems.
3. Learn production planning, operation scheduling and project scheduling.

Module-I

Fundamentals of Systems: Basic concepts of systems and chaos, Definition of systems, basic problems concerning systems, systems design, decision making Procedures. Fundamentals of Manufacturing Systems: Structural aspects of Manufacturing systems, transformational aspect of manufacturing systems, Integrated Manufacturing Systems (IMS) [08]

Module-II

Modes of Production: Types of Production, Mass Production, Multi-product, small batch production, production diversification. Integrated Manufacturing and Management systems: Basic functions and structures of management systems, Basic framework of integrated Manufacturing Management Systems, Framework of an Integrated Manufacturing System. Material & Technological information flows in Manufacturing Systems: Logistic Systems, Material flow, Technological information flow. [12]

Module-III

Product Planning & Design: Product Planning, Product Design. Process Planning & Design: Process Design, Operation Design, Optimum Routing Analysis, Line balancing, Layout Planning & Design: Scope & Problems of layout planning, Systematic layout Planning (SLP), Mathematical Layout Design, Production Flow Analysis, Logistic Planning & Design: Transportation Problems, Distribution ProblemsManufacturing Optimization: Evaluation criteria for Manufacturing optimization, Optimization of single stage Manufacturing, Optimization of Multi-stage Manufacturing Systems. [10]

Module-IV

Managerial Information flow in Manufacturing Systems: Managerial information Flow, Decision Problems in Managerial Information Flow. Aggregate Production Planning: Production Planning Defined, Short-term Production Planning, Multiple-objective Production Planning, Product Mix Analysis, Lot-size Analysis, Material Requirements Planning (MRP) & Machine Loading, Long-term Production Planning, Production ForecastingProduction Scheduling: Operations, Scheduling, Project Scheduling-PERT & CPM. [10]

Text Book(s):

1. Manufacturing Systems Engineering, K Hitomi, T & F.
2. Manufacturing Systems Engineering, Bhaduri.

Reference Book(s):

1. Manufacturing Systems Engineering- S. Gershwin, PrenticeHall.
2. Factory Physics- M. Spearman and W. Hopp, McGraw Hill.

Course Outcomes:

At the end of the course the students shall be able to:

1. Develop integrated manufacturing system models for industrial products with adequated managerial information.
2. Design and Plan product and production including operation scheduling, layout planning and project planning.

Elective Subjects (Any two) 2 × (3-1-0)

1. Computer Aided Product Design

Course Objectives:
The general objectives of the course are to enable the students to

1. Understand integrated product development, concurrent engineering and product models.
2. Learn general and computational architecture of concurrent engineering environment.
3. Learn design for manufacturing & assembly and developmment of intelligent information system.

Module-I
Integrated Product development process, Concurrent engineering, Work structuring and team Deployment, Product and process systemization - problem, identification and solving methodologies. [08]

Module-II
Product Modeling- Definition of concepts, Fundamental issues, Role of Process chains and product models, Types of product models - model standardization efforts, Types of process chains. [10]

Module-III
Introduction, General Architecture, Distributed computing, Work group computing, PIM – ComputationalArchitecture – Standards, Generic concurrent engineering development environment. [08]

Module-IV
Design for manufacturability – Machining, Casting and metal forming, Optimum design, Design for assemblyand disassembly, Probabilistic design concepts - FMEA - QFD - Taguchi Method for design of experiments -Design for product life cycle. [08]

Intelligent Information Systems - Knowledge based product and process models, Applications of soft computing in product development process, advanced database design for integrated manufacturing, Use of STEP standards in CIM. Design for manufacturability - casting, forming, welding and machining. [06]

Text Book(s):
1. Concurrent Engineering Fundamentals Vol II- Biren Prasad, Prentice Hall.
2. Product Design and Development- K.T.Ulrich & S.D.Eppinger, McGraw Hill.

Reference Book(s):
1. Concurrent Engineering- D.E.Carter, Addison Wesley.
2. Handbook of Product Design for Manufacturing- J.G.Bralla, McGraw Hill.

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

1. Develop computational architecture for concurrent engineering development architecture.
2. Design database for integrated manufacturing and develop knowledge base for product and process.

2. Rapid Manufacturing Processes

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand fundamentals of rapid manufacturing processes, their principles and applications.
2. Learn toolings involved in rapid manufacturing processes.
3. Learn software aspects of rapid manufacturing including product modeling.

Module-I

Introduction: Definition of GMP and Rapid Prototyping, Types of prototype, Need for the compression in product development, Survey of applications, Issues related to GMP, Classification of RP systems. Stereolithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Physical layer Model Development, Applications. [10]

Module-II

Selective Laser Sintering: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications. Solid Ground Curing: Principle of operation, Machine details, Applications, Laminated Object Manufacturing: Principle, LOM materials, process details, application. [10]

Module-III

Concepts Modelers: Principle, Thermal jet printer, 3-D printer, Genisys Xsprinter HP system 5, Object Quadra systems, Laser Engineering Net Shaping (LENS). [04]

Rapid Tooling: Indirect Rapid tooling -Silicon rubber tooling- Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3D keltool, Direct Rapid Tooling- Direct, AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, ProMetal, Sand casting tooling, Laminate tooling, Soft Tooling vs. Hard tooling. [06]

Module-IV

Software for RP: STL files, Overview of Solid view, magics, mimics, magic communicator, etc. Internet based software, Collaboration tools, Rapid Manufacturing Process Optimization: factors influencing accuracy, data preparation errors, Part building errors, Error in finishing, influence of build orientation. Surface digitizing, surface generation from point cloud, surface modification-data transfer to solid models. [10]

Text Book(s):

1. Stereolithography and other RP& M Technologies- Paul F. Jacobs, Society of Manufacturing Engineers, NY.
2. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling- D.T. Flham and S.S.Dimov, Springer Verlag.

Reference Book(s):

1. Rapid Prototyping: Principles and Applications in Manufacturing- Kai and Fai, World Scientific.
2. Rapid Prototyping & Manufacturing- Paul F. Jacobs, McGraw-Hill.

Course Outcomes:

At the end of the course the students shall be able to:

1. Describe the currently available rapid prototyping systems, and related complementary, secondary fabrication processes commonly used with them.
2. Select the appropriate fabrication technology, or technologies, for a given prototyping task.

3. Design of Hydraulic & Pneumatic Systems

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand specifications, characteristics, selection and flow control of hydraulic actuators.
2. Learn hydraulic circuit for industrial equipment.
3. Understand the fundamantals of pneumatic systems circuits.
4. Understand automation of hydraulic and pneumatic circuits.

Module-I

Hydraulic Power Generators- Selection and specification of pumps, pump characteristics.Linear and Rotary Actuators- selection, specification and characteristics.Pressure- direction and flowcontrol valves- relief valves, non-return and safety valves - actuation systems. [08]

Module-II

Reciprocation, quick return, sequencing, synchronizing circuits- accumulator circuits- industrial circuits- presscircuits- hydraulic milling machine- grinding, planning, copying, forklift, earth mover circuits- design and selection of components- safety and emergency mandrels. [12]

Module-III

Pneumatic fundamentals- control elements, position and pressure sensing-logic circuits- switching circuits-fringe conditions modules and integration- sequential circuits- cascade methods- mapping methods- stepcounter method- compound circuit design- combination circuit design. [12]

Module-IV

Pneumatic equipments - selection of components - design calculations-application- fault finding-hydropneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation-Robotic circuits. [08]

Text Book(s):

1. Fluid power with Applications- Antony Espossito, Prentice Hall.
2. Basic Fluid Power- D. A. Pease and J.J. Pippenger, Prentice Hall.

Reference Book(s):

1. Hydraulic and Pneumatics- A. Parr, Jaico Publishing House.
2. Pneumatic and Hydraulic Systems- W. Bolton, Butterworth - Heineman.

Course Outcomes:

At the end of the course the students shall be able to:

1. Select proper hydraulic and pneumatic system and design required circuits.
2. Automate system using microprocessor for industrial application.

4. Finite Element Analysis in Manufacturing

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand fundamantals of finite element method as a problem solving tool for linear and non-linear problem solving tool.
2. Learn application of FE analysis to manufacturing.
3. Acquaint with FE software packages widely used by industries.

Module-I

Basics of FEM- Initial value and boundary value problems- weighted residual, Galerkin and Raleigh Ritzmethods- Review of Variational calculus-Integration by parts- Basics of variational formulation.Steps in FEA- Discretization, Interpolation, derivation of element characteristic matrix, shape function, assembly and imposition of boundary conditions- Solution and post processing- One dimensional analysis insolid mechanics and heat transfer. [12]

Module-II

Global and Natural co-ordinates- Shape functions for one and two dimensional elements- Three nodedtriangular and four noded quadrilateral element- Nonlinear analysis- Isoparametric elements- Jacobianmatrices and transformations- Basics of two dimensional axi-symmetric analysis. [08]

Module-III

FE analysis of metal casting- Special considerations, latent heat incorporation, gap element- Time steppingprocedures- Crank- Nicholson algorithm- Prediction of grain structure- Basic concepts of plasticity- Solid andflow formulation- Small incremental deformation formulation- FE analysis of metal cutting, chip separationcriteria, incorporation of strain rate dependency. [10]

Module-IV

Pre Processing, Mesh generation, element connecting, boundary conditions, input of material and processing characteristics- Solution and post processing- Overview of application packages such as ANSYS andDEFORM- Development of code for one dimensional analysis and validation. [10]

Text Book(s):

1. An Introduction to the Finite Element Method- J.N. Reddy,McGraw-Hill.
2. Finite Element Method in Engineering- S.S. Rao, Pergammon Press.

Reference Book(s):

1. Metal Forming and the Finite Element Methods- S. Kobayashi, Soo-Ik-Oh and T. Altan, Oxford University Press.
2. The Finite Element Methodin Heat Transfer Analysis- R.W. Lewis, K. Morgan, H.R. Thomas and K.N. Seetharaman, JohnWiley.

Course Outcomes:

At the end of the course the students shall be able to:

1. Develop their mathematical skills through applications.
2. Realize the importance and potential of computer aided analysis tools in the context of manufacturing engineering.
3. Experience use of commercial FE packages.

5. Quality Engineering

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand fthe principles of quality management and applied quality engineering methods.
2. Learn methods of statistical process control
3. Understand sampling problems and learn acceptance sampling plans methods.

Module-I

Principles of Quality Management- Pioneers of TQM, Quality costs, Quality system Customer Orientation, Benchmarking, Re-engineering, Concurrent Engineering. [06]

Leadership- Organizational Structure, Team Building, Information Systems and Documentation, Quality Auditing- ISO 9000- QS 9000. [06]

Module-II

Single Vendor Concept- JIT, Quality Function deployment, Quality Circles, KAIZEN, KAIYRO SGA, POKA-YOKE, Quality function deployment, PDCA cycle, Quality Circle,Taguchi Methods. [08]

Module-III

Methods and Philosophy of Statistical Process Control, Causes of variations, , Natural tolerance limits, Specification Limits, Trial and Revised Control limits, Rational Subgroups Control Charts for Variables and Attributes, Cumulative sum and exponentially weighted moving average control charts, OC curve, Others SPC Techniques- Process Capability Analysis- Six sigma accuracy. [10]

Module-IV

Acceptance Sampling Problem, Single Sampling Plans for attributes, Double, multiple and sequential sampling, Military standards, The Dodge-Roming sampling plans. [10]

Text Book(s):

1. Total Quality Management for Engineers- M. Zairi, Woodhead Publishing.
2. Introduction to Statistical Quality Control- D.C. Montgomery, John Wiley and Sons.

Reference Book(s):

1. ISO 9000- A Manual for Total Quality Management- S. Dalela and Saurabh, S.Chand and Company Ltd.
2. Statistical Quality Control- E.L. Grant and Leavensworth, McGraw-Hill.

Course Outcomes:

At the end of the course the students shall be able to:

1. Implement quality concepts in industrial environments.
2. Develop control charts for variables and attributes.
3. Prepare sampling plans using multiple and sequential sampling.

6. Design Optimization

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the fundamental concepts of Optimization Techniques
2. Learn concepts of various classical and modern methods of for constrained and unconstrained problems in both single and multivariable.
3. Learn practical aspects of optimization methods.

Module-I

General Characteristics of mechanical elements, adequate and optimum design, principles of optimization, formulation of objective function, design constraints, classification of optimization problems. Single and multivariable optimization techniques. [08]

Module-II

Technique of unconstrained minimization. Golden section, Random, Pattern and Gradient search methods, interpolation methods, equality and inequality constraints. [10]

Module-III

Direct methods and indirect methods using penalty function, Lagrange multipliers, Geometric programming, stochastic programming, Genetic algorithms. [10]

Module-IV

Engineering applications, structural-design application axial and transverse loaded members for minimum cost, maximum weight. Design of shafts and torsion members, design optimization of springs. Dynamics applications for two-degree freedom system. vibration absorbers. Application in mechanisms. [12]

Text Book(s):

1. Engineering Optimization -Theory and Practice, S S. Rao, New Age.
2. Optimum Design of Mechanical elements, Johnson Ray C, Wiley, John & Sons

Reference Book(s):

1. Genetic Algorithms in search, Optimization and Machine, Goldberg D. E., Addison Wesley.
2. Optimization for Engineering Design Algorithms and Examples, K. Deb, PHI.
3. Introduction to Optimum Design, Jasbir S. Arora, Academic Press.

Course Outcomes:

At the end of the course the students shall be able to:

1. Formulate optimization problems in single variable as well as multivariable.
2. Apply the concept of optimality for various type of constrained and unconstrained optimization problems.
3. Solve both static and dynamic industrial optimization problems.

Manufacturing Systems Lab.-I

Course Objectives:

The general objectives of the course are to enable the students to

1. Identify the components of coordinate measuring machine and measuring techniques.
2. Understand the geometrical features of gears and their measurement with profile projector.

Coordinate measuring machine- distance between two holes, parallelism, circularity, Profile projector- gear profile measurement (geometrical features), metric thread geometrical features measurements.

Course Outcomes:

At the end of the course the students shall be able to:

1. Measure dimension of parts using coordinate measuring machine and profile projector.
2. Handle industrial measuring equipment.
3. Formulate a basis for reverse engineering

SEMESTER-II

1. **Laser Processing of Materials(3-1-0)**

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the principles of laser and the operations of different types of lasers.
2. Learn thermal and metallurgical aspects of laser processing.
3. Describe laser maching and joining.

Module-I

Laser Systems- Laser beam characteristics, laser principles, High power lasers for materials applications, Principles and working of CO2, Nd:YAG and Excimer laser, Optics for irradiation. [08]

Module-II

Thermal process in Interaction zones- Laser Materials processing parameters, Conduction and convection, Analytical models in one dimensional heat flow, Depth of irradiation with respect to energy density, Reflectivity of material with respect to wave length, Rate of heating, cooling and temperature gradient. [12]

Module-III

Laser Metallurgy- Laser surface treatment, Transformation hardening, Rapid quenching, Methods to obtain desired penetration depths, Laser surface alloying, Laser surface cladding, Shock hardening, Advantages of laser surface treatment. [10]

Module-IV

Laser Cutting and Drilling- Laser instrumentation for cutting and drilling, cut quality and process characteristics, methods of cutting. Laser Welding- Process mechanisms (Key hole and Plasmas), operating characteristics, process variations, imperfections. [10]

Text Book(s):

1. Opto electronics – An introduction- W. J. Hawkes, Prentice Hall of India.
2. Laser Processing of Engineering Materials- J.C. Ion,Butter Worth-Heinemann.

Reference Book(s):

1. Laser Materials Processing- W.M. Steen, Springer Verlag.
2. High power laser applications- J.F.Reddy, Academic Press.

Course Outcomes:

At the end of the course the students shall be able to:

1. Select appropriate laser for specific industrial use.
2. Identify and optimize laser parameters for material processing.
3. Use laser based equipment for surface coating, machining and welding.

2. Discrete System Simulation (3-1-0)

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the basic system concept and definitions of system;
2. Learn modeling techniques to model and to simulate various systems
3. Analyze a system and make use of the information to improve the performance.

Module-I

Systems, modeling, general systems theory, concept of simulation, simulation as a decision making tool, types ofsimulation.Pseudo random numbers, methods of generating random variates, discrete and continuous distributions, testingof random numbers. [08]

Module-II

Problem formulation, data collection and reduction, time flow mechanism, key variables, logic flow chart,starting condition, run size, experimental design consideration, output analysis and interpretation validation. [08]

Module-III

Comparison and selection of simulation languages, study of any one simulation language. [10]

Module-IV

Development of simulation models using the simulation language studied for systems like, queuing systems,production systems, Inventory systems, maintenance and replacement systems, investment analysis andnetwork. [14]

Course Outcomes:

At the end of the course the students shall be able to:

1. Apply functional modeling method to model the activities of a static system.
2. Understand the behavior of a dynamic system and create an analogous model for a dynamic system.
3. Simulate the operation of a dynamic system and make improvement according to the simulation results.

Text Book(s):

1. Discrete eventsystem simulation- J. Banks, J.S. Carson, B.L. Nelson, D.M. Nicol, PHI.
2. Simulation using GPSS- T.J. Schriber, John Wiley.

Reference Book(s):

1. Simulation Techniques for Discrete Event Systems- I.Mitrani, Cambridge University Press.
2. Simulation Modeling and Analysis- A.M. Law, McGraw Hill India.

3. Robotics and Robot applications (3-1-0)

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the components and their working principles of a robotic system.
2. Learn forward kinematics, inverse kinematics and dynamic modeling of manipulators.
3. Learn robot programming and industrial application of robots.

Module-I

Robot Fundamentals: Definitions, History of robots, Laws of Robotics, Robot Specification, Anatomy of a Robot, Robot classifications, Function line diagram representation of robot arms, common types of arms, Robot end effectors- Types, Tools as end effectors, Considerations in gripper selection and design. [06]

Manipulator Kinematics: Homogeneous coordinate transformation, matrix representations of coordinate transformation, D-H representation of kinematics linkages, Forward and Inverse Kinematics of manipulators, Euler's angle and fixed rotation for specifying position and orientation. [08]

Module-II

Robotics Dynamics: Velocity Kinematics, Acceleration of rigid body, Lagrange-Euler Formulation, Newton–Euler's formulation. [04]

Trajectory Planning: General considerations in path description and generation, Joint space schemes, Cartesian space schemes, 4-3-4 &trapezoidal velocity strategy for robots. [04]

Module-III

Robot Actuators and Sensors: Internal and external sensors, Position- potentiometric, Optical sensors, Encoders - absolute, incremental, Touch and slip sensors, Velocity and acceleration sensors, Proximity sensors, Force and torque sensors. Actuators- Hydraulic, Pneumatic and Electrical, Comparison of actuating systems and their relative merits and demerits. [08]

Module-IV

Robot Programming: Methods of robot programming- Textual and Leadthrough, WAIT, SIGNAL and DELAY commands, Capabilities and limitations of leadthrough programming, Robot language structure, Motion, sensor and end effectors commands, Programming examples. [06]

Robot application in Manufacturing- Material Transfer- Material handling, loading and unloading, Processing - spot and continuous arc welding and spray painting, Assembly and Inspection. [04]

Text Book(s):

1. Industrial Robotics- Groover M P et al, Pearson Education.
2. Robotics and Control- Mittal R K & Nagrath I J, TMH.

Reference Book(s):

1. Robotics Technology and Flexible Automation- S.R.Deb, TMH.
2. Robotic Engineering- Richard D. Klafter, PHI.

Course Outcomes:

At the end of the course the students shall be able to:

1. Select a Robot for a specific application.
2. Identify parameters required to be controlled in a Robot.
3. Develop small automatic / autotronics applications with the help of Robotics.

Elective Subjects (Any two) 2 × (3-1-0)

1. Diagnostic Techniques

Course Objectives:
The general objectives of the course are to enable the students to

1. Understand type and causes of equipment failure and their maintenance.
2. Build an understating of the principles of condition monitoring and provide background to vibration, temperature, other factors required.
3. Learn different maintenance systems.

Module-I
Defect generation-types of failures, Defects reporting and recording, Defect analysis, Failureanalysis, Equipment downtime analysis, Breakdown analysis-FTA,FMEA,FMECA.

Planned and unplanned maintenance-Breakdown maintenance, Corrective maintenance, Opportunisticmaintenance, Routine maintenance, Preventive maintenance, Predictive maintenance. [10]

Module-II
Condition based maintenancesystem-Design out maintenance-selection of maintenance system.Codification and Cataloguing-Instruction manual and operating manual, Maintenance manual and Departmentalmanual, Maintenance time standard, Maintenance work order and work permit, job monitoring-Feedback andcontrol, Maintenance records and documentation.
[10]

Module-III
Selection and scope of computerization-Equipment classification, Codification of breakdown,material andfacilities, Job sequencing, Material management module, Captive Engineering module.
[08]

Module-IV

Condition monitoring techniques, Visual monitoring, Temperature monitoring, Vibration monitoring, Lubricantmonitoring, Cracks monitoring, Thickness monitoring, Noise and sound monitoring, Condition monitoring ofhydraulic system.

Machine diagnostics-Objectives, Monitoring strategies, Examples of monitoring and Diagnosis, Control structures for machine diagnosis. [12]

Text Book(s):
1. Industrial Maintenance Management- S. K. SRIVASTAVA, S.Chand & CompanyLtd.
2. Handbook of Machine Tools- Vol. 3- M. Weck and H.Bibring, John Wiley &Sons.

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

1. Identify type of failure and look at maintenance planning
2. Design maintenance system and improve the system through automation.
3. Apply condition monitoring system to industrial equipment.

2. Manufacturing Information Systems

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand computer-based information systems to support the design and management of manufacturing systems.
2. Understand database model, data structures for various product structure.
3. To lean part oriented production management and information systems.

Module-I

Introduction: The evolution of order policies, from MRP to MRP II, Role of Production Organization, Operations Control.Database: Terminologies, Entities and attributes, Data models, schema and subschema, Data Independence, ER Diagram, Trends in database. [6]

Module-II

Designing Database: Hierarchical model, Network approach, Relational Data model -concepts, principles, keys, relational operations - functional dependence -Normalisation, types - Query languages. [12]

Module-III

Manufacturing Considerations: The product and its structure, Inventory and process flow, Shop floor control - Data structure and procedure - various model - the order scheduling module, input/output analysis module the stock status database, the complete IOM database. [09]

Module-IV

Information System for Manufacturing: Parts oriented production information system - concepts and structure -computerised production scheduling, online production control systems, Computer based production management system, computerised manufacturing information system - case study. [09]

Text Book(s):

1. Manufacturing Information Systems- L.G. Sartori, Addison-Wesley PublishingCompany.
2. An Introduction to Database Systems- C.J. Date.C.J., Narosa Publishing House.

Reference Book(s):

1. Material Requirements Planning- G. Orlicky, McGraw-Hill.
2. Knowledge based Manufacturing Management- R. Kerr.Addison-Wesley.

Course Outcomes:

At the end of the course the students shall be able to:

1. Design product centered database system.
2. Develop information system for shopfloor manufacturing and control.
3. Apply computer based production management system.

3. Mechatronics& MEMS (3-1-0)

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand architecture of the mechatronics system design and characteristics of sensors and actuators and their selection for mechatronic systems.
2. Learn the basic concepts of microprocessor, microcontroller and PLC used in mechatronics system.
3. Learn underlying concepts of MEMS and its applications in micro-manufacturing.

Module-I

Introduction: Introduction to Mechatronics: Mechatronic system, measurement systems, control systems and response of systems, Open and Closed loop System, Transfer Function, Sequential Controller, Microprocessor based controller. Basic System models: Mathematical models, Introduction to Mechanical, Electrical, Fluid and Thermal systems, Rotational and Transnational systems, Electro-Mechanical, Hydraulic- Mechanical systems. [10]

Module-II

Sensors and transducer: Desirable features, Displacement, position and proximity sensors, Velocity, motion and Force sensors, Time of flight sensors, Binary force sensor, temperature and Pressure measurement, Sensor selection.Actuation Systems: Actuation Systems, Pneumatic and Hydraulic systems, Directional control valves, Rotary actuator, Mechanical actuation systems- Mechanical Systems, Electrical Actuation Systems- Electrical Systems, Relays and Solenoids, DC brushed motors, DC brushless motors, DC servo motors, Stepper Motors. Drive selection. [10]

Module-III

Microcontrollers: 8051 Microcontroller, Microprocessor structure, Programmable Logic Controllers: Basic Structure, Programming- Ladder diagram, Timers, Internal Relays and Counters Shift Registers, Master and Jump Controls, Data Handling, Analog input / output, PLC Selection, Application. [08]

Module-IV

Introduction to MEMS technology**:** Basic definitions, MEMS Materials: Mechanical and other properties of materials used in MEMS Microfabrication / Micromachining: Overview of microfabrication, Review of microelectronics fabrication processes like photolithography, deposition, doping, etching, structural and sacrificial materials. , other lithography methods, MEMS Modeling:Basic modeling elements in electrical, mechanical, thermal and fluid systems, analogy between 2nd order mechanical and electrical systems. Modeling elastic, electrostatic, electromagnetic systems. [12]

Text Book(s):

1. Mechatronics- W Bolton, Pearson Education.
2. MEMS and Microsystems Design and Manufacture**-** Tai, Ran Hsu, TMH.

Reference Book(s):

1. Mechatronics Principles and Applications- G.C.Onwubolu, Butterworth-Heinemann.
2. Foundations of MEMS**-** Chang Liu, Pearson International Edition.
3. Fundamentals of Microfabrication**-** Madou, CRC Press.

Course Outcomes:

At the end of the course the students shall be able to:

1. Interface sensor and actuator for a mechatronic system.

2. Indigenously design and develop a mechatronic system.
3. Design and develop MEMS for various industrial applications.

4. Computer Integrated Manufacturing (3-0-0)

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the concept and integration of manufacturing enterprise using CIM technologies.
2. Learn methods of group technology, computer aided process planning and control of FMS necessary for implementation of CIM.
3. Understand basic concepts of CIM database and data communication in CIM.

Module-I

Introduction: The meaning and origin of CIM, The changing manufacturing and management scenario, External communication, Islands of automation and software.

Dedicated and open systems, Manufacturing automation protocol, Product related activities of a company, Marketing engineering, Production planning, Plant operations, Physical distribution, Business and financial management. [08]

Module-II

Group Technology: History of group technology, Role of GT in CAD/CAM integration, Part families - classification and coding, DCLASS, MICLASS and OPITZ coding systems, Facility design using GT, Benefits of GT, Cellular manufacturing.

Computer Aided Process planning: Role of process planning in CAD/CAM integration, Approaches to computer aided process planning- Variant approach and Generative approaches, CAPP and CMPP process planning systems. [08]

Module-III

Shop Floor Control and FMS: Shop floor control-phases, Factory data collection system, Automatic identification methods- Bar code technology, Automated data collection system, FMS-components of FMS - types -FMS workstation, Material handling and storage systems, FMS layout, Computer control systems-application and benefits.

CIM Implementation: CIM and company strategy, System modeling tools-IDEF models, Activity cycle diagram, CIM open system architecture (CIMOSA), Manufacturing enterprise wheel, CIM architecture, Product data management, CIM implementation software. [12]

Module-IV

Data Communication: Communication fundamentals, Local area networks, Topology, LAN implementations, Network management and installations.

Open System: Open systems, Open system inter-connection, Manufacturing automations protocol and technical office protocol (MAP /TOP).

Database for CIM: Development of databases, Database terminology, Architecture of database systems, Data modeling and data associations, Relational data bases, Database operators, Advantages of data base. [12]

Text Book(s):

1. Computer Integrated Manufacturing System- Y. Koren, McGraw-Hill.
2. Automation, Production Systems and Computer Integrated Manufacturing- M.P.Groover, Pearson Education.

Reference Book(s):

1. CAD/CAM/CIM- P. Radhakrishnan, S. Subramanyan and V. Raju- New Age International(P) Ltd.
2. Computer Integrated Manufacturing- Paul G. Ranky, Prentice Hall International.

Course Outcomes:

At the end of the course the students shall be able to:

1. Develop an understanding of computer-integrated manufacturing (CIM) and its impact onproductivity, product cost, and quality.
2. Obtain an overview of computer technologies including computers, database and datacollection, networks, machine control, etc, as theyapply to factory management andfactory floor operations.
3. Describe the integration of manufacturing activities into a complete system.

5. Concurrent Engineering

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the basic tools and methodologies available in CE.
2. Learn conventional and intellegent manufacturing system design.
3. Learn CE approach to economical project management.

Module-I

Introduction: Extensive definition of CE - CE design methodologies, Organizing for CE, CE tool box collaborative product development. Use of Information Technology: IT support, Solid modeling, Product data management, Collaborative product commerce, Artificial Intelligence - Expert systems - Software hardware co-design. [12]

Module-II

Design Stage: Life-cycle design of products, Opportunity for manufacturing enterprises, Modality of Concurrent Engineering Design, Automated analysis idealization control, Concurrent engineering in optimal structural design - Real time constraints. [08]

Module-III

Manufacturing Concepts and Analysis: Manufacturing competitiveness, Checking the design process, Conceptual design mechanism- Qualitative Physical approach, An intelligent design for manufacturing system, JIT system, Low inventory, Modular, Modeling and reasoning for computer based assembly planning, Design of Automated manufacturing. [10]

Module-IV

Project Management: Life Cycle semi realization, Design for economics, Evaluation of design for manufacturing cost, Concurrent mechanical design, Decomposition in concurrent design, Negotiation in concurrent engineering design studies, Product realization taxonomy, Plan for Project Management on new product development, Bottleneck technology development. [10]

Text Book(s):

1. Concurrent Engineering Fundamentals: Integrated Product Development- Prasad, Prentice Hall.
2. Concurrent Engineering: Automation Tools and Technology- Andrew Kusaik, Wiley.

Reference Book(s):

1. Integrated Product Development- Anderson MM and Hein, L. Berlin, Springer Verlag.
2. Successful Implementation of Concurrent Product and Process- Sammy G Sinha, Wiley.

Course Outcomes:

At the end of the course the students shall be able to:

1. Design concurrent engineering system for product and process in manufacturing enterprises.
2. Plan for project management on new product development.

6. Image Processing in Manufacturing

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the digital image fundamentals and geometric models for imaging.
2. Learn transformation of images and image processing.
3. Laern 3D image visualization and its industrial applications.

Module-I

Image representation and nomenclature, Relationship of image processing and computer vision, Digital imagefundamentals, Geometric model for imaging and applications- Imaging requirements. [08]

Module-II

Image transformers-Sampling, Enhancement, Restoration and conversions, Segmentation, Thresholdingrepresentation and description. [10]

Module-III

Processing binary images-Image measurements, Multilevel image analysis, Higher dimensional modeling, Imagebased knowledge manipulation. [10]

Module-IV

2D/3D Image acquisition, 3D image Visualisation, Imaging surfaces, Image processing system components.

Study of surface finish - Sorting and counting of objects, Tool Wear measurement,measurement technique, Robot application. [12]

Text Book(s):

1. The Image Processing Hand Book- J.C. Russ, CRC Press/IEEE Press.
2. Digital Image Processing and Computer Vision- R. J. Schalkoff, John Wiley & Sons.

Reference Book(s):

1. Digital Image Processing- R. C. Gonzalez & R. E. Woods, Addison Wesley.
2. Introduction to Machine Vision- R. C. John, Tata McGraw Hill.

Course Outcomes:

At the end of the course the students shall be able to:

1. Acquire images, transformation and processsing for industrial applications.
2. Use image processing system and apply in practice.

Manufacturing Systems Lab.-II

Course Objectives:

The general objectives of the course are to enable the students to

1. Understand the working principle of non-conventional machining.
2. Learn the fundamental of robotics and robot applications.
3. Learn principle of operation of FMS.

NTM Laboratory: Laser beam machining, Electro-discharge machining, Laser micro drilling, Ultrasonic machining, Abrasive jet machining.

Robotics Laboratory: Pick and place operation in robots, robot programming, operation of FMS

Course Outcomes:

At the end of the course the students shall be able to:

1. Perform machining on non-conventional machines and control parameter settings for process optimization.
2. Write offline programmes for industrial applications of robots.
3. Operate FMS productively.