Detailed Syllabus Two year Postgraduate Degree Course (M.Tech.) in Production Engineering with specialization in CAD/CAM& Robotics.

Semester-I

1.0 Advanced CAD (3-1-0)

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

1. Understand the generation of geometrical primitives in a graphics system.
2. Learn principles of geometrical modelling of curves and surfaces.
3. Learn CAD data formats in practice and practical applications.

Module-I
Principle of Computer Graphics: Introduction,graphics primitives,pointplotting,lines, Bresenham'scirclealgorithm,ellipse,transformationingraphics,coordinatesystems,viewport, 2D and 3D transformation, hidden surface removal, reflection, shading and generation of characters.CAD Tools: DefinitionofCADTools,Typesofsystem,CAD/CAMsystemevaluationcriteria, brieftreatmentofinputandoutputdevices.Graphicsstandard,functionalareasofCAD,Modeling andviewing, software documentation, efficientuse CAD software.
[12]

Module-II
Geometric Modeling:Typesofmathematicalrepresentationofcurves,wireframemodels wireframeentitiesparametricrepresentation of syntheticcurveshermitecubicsplines, Bezier curvesB-splinesrationalcurves.

Surface Modeling: Mathematicalrepresentationsurfaces,Surfacemodel,Surfaceentities surfacerepresentation,Parametric representationofsurfaces, plane surface, rule surface, surfaceofrevolution,TabulatedCylinder.
[12]

Module-III
ParametricRepresentation ofSyntheticSurfaces:HermiteBicubicsurface,Bezier surface,B-Splinesurface,COONssurface,Blendingsurface Sculpturedsurface,Surface manipulation-Displaying,Segmentation,Trimming, Intersection, Transformations(both2Dand3D). Geometric modeling - 3D Solid modeling, Representation, Boundary Representation (B-rep),ConstructiveSolid Geometry(CSG). [08]

Module-IV
CAD/CAMExchange: Evaluation of data exchange format, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF. Design Applications: Mechanicaltolerances, Mass property calculations,FiniteElementModelingandAnalysisandMechanicalAssembly. Collaborative Engineering:Collaborative Design, Principles, Approaches, Tools, Design Systems.
[08]

Text Book (s)

1. MasteringCAD/CAM, IbrhimZeid, TMH.
2. CAD/CAM, GrooverM.P., Pearson.

Reference Book (s)

1. CAD/CAM/CIM,RadhakrishnanandSubramanian, NewAge
2. PrinciplesofComputerAidedDesignandManufacturing, FaridAmirouche, Pearson

Course Outcomes:

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

1. Model complex surfaces and solids.
2. Exchange data files in to other systems for design and analysis.

2.0 Finite Element Analysis in Manufacturing (3-1-0)

Course Objectives:

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

1. Understand fundamentals 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 Ritz methods- 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 in solid mechanics and heat transfer. [12]

Module-II

Global and Natural co-ordinates- Shape functions for one and two dimensional elements- Three noded triangular and four noded quadrilateral element- Nonlinear analysis- Isoparametric elements- Jacobian matrices 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 stepping procedures- Crank- Nicholson algorithm- Prediction of grain structure- Basic concepts of plasticity- Solid and flow formulation- Small incremental deformation formulation- FE analysis of metal cutting, chip separation criteria, 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 and DEFORM- 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, Pergamon 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 Method in 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.

3.0 Design for Manufacturing and Assembly (3-1-0)

Course Objectives:

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

1. Understand general design considerations and design manufacturing operations for lowest cost.
2. Get an insight into the economic design for manufacturability of machining, casting and welding.
3. Understand the assembly process and its design aspects.

Module-I

Fundamentals of design:Design philosophy steps in Designprocess - General Design rules for manufacturability-basicprinciplesofdesign designing for economicalproduction-creativityindesign. Materials: Selection of Materialsfor design DevelopmentsinMaterialtechnology- criteria for materialselection-Materialselectioninterrelationshipwithprocessselection, processselection charts. [08]

Module-II

Machining Process:Overviewofvariousmachining processes– general design rulesfor machining - Dimensional tolerance and surfaceroughness – Designfor machining –Ease – Redesigning of componentsformachining easewithsuitable examples. General design recommendationsformachinedparts. Metal Casting: Appraisalofvariouscastingprocesses, selectionofcasting process, generaldesignconsiderationsforcasting-castingtolerances–use ofsolidification, simulationincastingdesign-productdesignrulesforsandcasting.

[10]

Module-III

Metal Joining:Appraisalof variousweldingprocesses,Factorsin design ofweldments – generaldesignguidelines-preandposttreatmentofwelds-effectsofthermalstressesinweld joints-designofbrazedjoints. Forging-Designfactorsforforging-Closeddies forgingdesign– partinglinesofdies dropforgingdiedesign – generaldesignrecommendations. Extrusion & Sheet MetalWork:Designguidelinesfor extruded sections– design principles forPunching, Blanking,Bending,DeepDrawing-KeelerGoodmanFormingLineDiagram-ComponentDesign forBlanking.

[10]

Module-IV

Assemble Advantages:Development oftheassembleprocess, choice of assemble methodassembleadvantages, socialeffectsofautomation. Automatic assembly Transfer systems: Continuoustransfer, intermittenttransfer, indexingmechanisms,andoperator-pacedfree–transfermachine.Design of Manual Assembly:Designforassemblyfitsinthedesignprocess,general designguidelinesformanualassembly,developmentofthesystematicDFAmethodology,assemblyefficiency,classificationsystemformanualhandling,classificationsystemformanual insertionandfastening,effectofpartsymmetryonhandlingtime,effectofpartthicknessandsize onhandlingtime,effectofweightonhandlingtime,partsrequiringtwohandsformanipulation, effects ofcombinationsoffactors,effectofsymmetryeffectofchamferdesignon insertion operations,estimationofinsertiontime. [12]

Text Book (s)

1. Assembly Automation and Product Design, Geoffrey Boothroyd, Marcel Dekker Inc., NY, 1992.
2. Engineering Design - Material & Processing Approach, George E. Deiter, McGraw Hill Intl. 2nd Ed. 2000.

Reference Book (s)

1. Product Design for Manufacturing and Assembly, Geoffrey Boothroyd, Peter Dewhurst & Winston Anthony Knight, CRC Press/2010
2. Hand Book of Product Design, Geoffrey Boothroyd, Marcel and Dekker.

Course Outcomes:

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

1. Outline the appropriate design for economical production and selection of materials.
2. Apply a systematic understanding of knowledge in the field of machining, metal casting and welding.
3. Fabricate basic parts and assemblies using powered and non–powered machine shop equipment.

Elective Subjects

Group-I (Elective-I & Elective-II) (3-1-0)

1. Mechatronics & MEMS

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, Elsevier 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.

2. Precision Engineering

Course Objectives:

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

1. Understand the principles of various micro and nano manufacturing methods.
2. Understand nano measuring and positioning systems.
3. Get and insight of nanaotechnology applications.

Module-I

Precision Engineering: Micromilling and Microdrilling, MicroElectroMechanical Systems, Microelectronics fabrication methods, Principles of MEMS, mechanical MEMS, Thermal MEMS, Magnetic MEMS.

Nanotechnology- Carbon nanotubes and Structures, Processing system of nanometre accuracies, mechanism of material processing, Nano Physical processing of atomic bit-units, Nano-chemical and electrochemical atomic-bit processing. [10]

Module-II

Nano-Measuring Systems of Sub-Nanometre Accuracy and Resolution: In process or in situ measurement of position of processing point, Post process and on machine measurement of dimensional features and surface, Mechanical measuring systems, Optical measuring systems, Electron beam measuring systems, Pattern recognition and inspection systems. [10]

Module-III

Nano-Positioning System of Nanometre Accuracy and Repeatability: Guide systems for moving elements, Servo control systems for tool positioning, Computer aided digital ultra precision position control, Future development of micro actuators. [08]

Module-IV

Applications of Nanotechnology: Nano-grating system, Nano lithography, Photolithography, Electron beam lithography, Machining of soft metal mirrors with diamond turning, Mirror grinding of ceramics, Ultra-precision block gauges, balls for rolling bearings, Fabrication CCD's, VCR head assemblies, Optical fibres. [12]

Text Book(s):

1. Introduction to Micromanufacturing- V.K.Jain, Narosa.
2. Nanotechnology- N. Taniguchi, Oxford University Press.
3. Micromanufacturing and Nanotechnology- N.P.Mahalik, Elsevier.

Reference Book(s):

1. Foundation of MEMS- C.Liu, Prentice Hall.
2. Introduction to Nanotechnology- C.P.Poole and F.J.Owens, Wiley Interscience.

Course Outcomes:

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

1. Apply knowledge in micro and nano manufacturing methods.

2. Develop MEMS system for industrial use.

3. 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, Failure analysis, Equipment downtime analysis, Breakdown analysis- FTA, FMEA, FMECA.

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

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

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

Module-IV
Condition monitoring techniques, Visual monitoring, Temperature monitoring, Vibration monitoring, Lubricant monitoring, Cracks monitoring, Thickness monitoring, Noise and sound monitoring, Condition monitoring of hydraulic 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& Company Ltd.
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.

4. 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 – Computational Architecture – Standards, Generic concurrent engineering development environment. [08]

Module-IV

Design for manufacturability – Machining, Casting and metal forming, Optimum design, Design for assembly and 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.

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. Computer Integrated Manufacturing

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 and: 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 on productivity, product cost, and quality.
2. Obtain an overview of computer technologies including computers, database and data collection, networks, machine control, etc, as they apply to factory management and factory floor operations.
3. Describe the integration of manufacturing activities into a complete system.

Sessional

Computer Aided Design Lab.(0-0-6)

Course Objectives:

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

1. Understand the concept of creating geometries with curves and solids and get acquainted with CAD commands.
2. Understand static and dynamics analysis and heat transfer problems.
3. Learn design analysis and optimization.

Creationofworkingdrawing,creatinggeometry,constrainingtheprofile,extractingatools,creatingpatternofholes, rotating,mirroring,managing thespecificationtree. Creatingsheetsandviews,creatingtext anddimensions,creating an assembly, moving components,assemblingexistingcomponents,creatingbillofmaterials,creatingwireframeand surfacegeometryusing generative shape design andsweeptools.Generationof Ferguson's cubicsurfacepatches,Beziersurface patches and Coonspatches.Importandexportofdrawingfromothersoftware.

Linearstaticanalysis,Automaticcalculationofrigidbodymodes,usesspecifiedeigenvalueshift,lumpedandconsistentmassmatrices.Bucklinganalysis,Jacobiinverseiterationtechniques.Steadystateharmonicresponse, modesuperpositionmethod,overallstructuralanddamping,lineardynamicanalysis,non-linearstaticanalysis,non-lineardynamicanalysis.

Steadystateheats transferanalysisproblems.Transientheats transferanalysis.Familiaritywithelementlibrary.DefiningBoundary conditions,multipointconstraintfamiliaritywithdifferenttypesofloads.Solutiontechniques,directanditerativesolver.Resultsandanalysis.Designoptimization.

Course Outcomes:

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

1. Design and analyse industrial systems and products.
2. Modify existing system through design optimization for better productivity.

Semester-II

Theory

1.0 Computer Aided Manufacturing (3-1-0)

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

1. Understand basic standard terminologies/ conventions, hardware, applications, merits and demerits of general NC, CNC, DNC technology.
2. Learn NC tool path programming using professional software tools used for complicated machining applications.
3. Learn concepts and application of microcontrollers.

Module-I
Computer aided Programming:Generalinformation,APT programming,ExamplesAPTprogrammingproblems(2Dmachiningonly).NCprogrammingonCAD/CAMsystems,thedesignandimplementationofpostprocessors.IntroductiontoCAD/CAMsoftware,AutomaticToolPathgeneration. [10]

Module-II
Tooling for CNC Machines:Interchangeabletoolingsystem,presetandqualified tools,coolantfedtoolingsystem,modularfixturing,quick changetooling system,automaticheadchangers.DNCSystemsandAdaptiveControl:Introduction,typeofDNCsystems,advantages and disadvantagesofDNC,adaptivecontrolwithoptimization,Adaptivecontrolwithconstrains,Adaptivecontrolofmachiningprocesseslike turning,grinding.
[10]

Module-III
Post Processors for CNC:IntroductiontoPostProcessors:ThenecessityofaPostProcessor,thegeneralstructureofaPostProcessor,thefunctionsofaPostProcessor,DAPPbased-PostProcessor:Communicationchannelsandmajorvariablesin theDAPP-basedPostProcessor,thecreationofaDAPP-BasedPostProcessor.

Micro Controllers:Introduction,Hardwarecomponents,I/Opins,ports,externalmemory:counters,timersandserialdataI/Ointerrupts.SelectionofMicro ControllersEmbeddedControllers,ApplicationsandProgrammingofMicroControllers.
ProgrammingLogicControllers(PLC's):Introduction,HardwarecomponentsofPLC,System,basicstructure,principleofoperations,Programmingmnemonicstimers,Internalrelaysandcounters,ApplicationsofPLC'sinCNCMachines. [12]

Module-IV

Computer Aided process Planning:HybridCAAPSystem,ComputerAidedInspectionandquality control,CoordinateMeasuringMachine,Limitations ofCMM,ComputerAided Testing, OpticalInspectionMethods,ArtificialIntelligence andexpertsystem:ArtificialNeuralNetworks,ArtificialIntelligenceinCAD,Expertssystemsanditsstructures. [08]

Text Book(s):

1. ComputerControlofManufacturingSystems, YoramKoren, McGrawHill.
2. CAD / CAM Theory and Practice, Ibrahim Zeid,TMH.

Reference Book(s)

1. CAD / CAM / CIM, Radhakrishnan and Subramanian, New Age.
2. Principles of Computer Aided Design and Manufacturing, FaridAmirouche, Pearson.
3. ComputerNumerical ControlConceptsandProgramming,W. S. Seames, Thomson.

Course Outcomes:

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

1. Workindividually and/or with an interdisciplinary team for the purpose of selection, design and use of NC technology for manufacturing applications.
2. Generate manual/automated part programs for a given part to be machined on NC/CNC system
3. Create and demonstrate the technical reports for manufacturing automation as well as withregard to NC machining.

2.0 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.

3.0 Automation in Manufacturing(3-1-0)

Course Objectives:

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

1. Understand basic concept and development of manufacturing automation.
2. Learn principles of assembly systems and material handling systems.
3. Understand quality control and other support systems used in automated systems.

Module-I

Overview of Manufacturing and Automation: Production systems, Automation in production systems, Automation principles and strategies, Manufacturing operations, production facilities. Basic elements of an automated system, levels of automation; Hardware components for automation and process control, programmable logic controllers and personal computers. [08]

Module-II

Manufacturing Systems and Automated Production Lines: Manufacturing systems: components of a manufacturing system, Single station manufacturing cells; Manual Assembly lines, line balancing Algorithms, Mixed model Assembly lines, Alternative Assembly systems. Automated production lines, Applications, Analysis of transfer lines. Automated Assembly Systems: Fundamentals, Analysis of Assembly systems. Cellular manufacturing, part families, coding, production flow analysis. Group Technology and flexible Manufacturing systems, Quantitative Analysis. [12]

Module-III

Material Handling and Identification Technologies: Material handling, equipment, Analysis. Storage systems, performance and location strategies, Automated storage systems, AS/RS, types. Automatic identification methods, Barcode Technology, RFID. [10]

Module-IV

Quality Control and Support Systems: Quality in Design and manufacturing, inspection principles and strategies, Automated inspection, contact Vs non-contact, CMM. Manufacturing support systems. Quality

function deployment, computer aided process planning, concurrent engineering, shop floor control, just in time and lean production.

[10]

Text Book(s):

1. Automation, Production Systems and CIM, MPGroover, PHI.
2. Computer Aided Manufacturing, T C Chang, R A Wysk and H-P Wang, Pearson.

Reference Book(s):

1. System Approach to Computer Integrated Design and Manufacturing, Singh, John Wiley.
2. Manufacturing and Automation Technology, RT Wright and MBerkeihiser, Good Heart/Willcox Publishers

Course Outcomes:

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

1. Design and simulate various automated manufacturing systems.
2. Solve complex industrial problems by different automation approaches.

Elective Subjects

Group-II (Elective-III & Elective-IV)

1. Computer Aided Process Planning

Course Objectives:

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

1. Understand basic concepts and types of computer aided process planning.
2. Learn selection of machining parameters and tolerances that will be used for process planning.
3. Learn CAPP implementation technique.

Module-I

Introduction to CAPP: Information requirement for process planning system, Role of process planning, advantages of conventional process planning over CAPP, Structure of Automated process planning system, feature recognition, methods. Generative CAPP system: Importance. principle of Generative CAPP system, automation of logical decisions, Knowledge based systems, Inference Engine, implementation, benefits.

Retrieval CAPP system: Significance, group technology, structure, relative advantages, implementation, and applications. Selection of manufacturing sequence: Significance, alternative-manufacturing processes, reduction of total set-up cost for a particular sequence. Quantitative methods for optimal selection, examples. [12]

Module-II

Determination of machining parameters: reasons for optimal selection of machining parameters, effect of parameters on production i-ate, cost and surface quality, different approaches, advantages of mathematical approach over conventional approach, solving optimization models of machining processes. [08]

Module-III

Determination of manufacturing tolerances: design tolerances, manufacturing tolerances, methods of tolerance allocation, sequential approach, integration of design and manufacturing tolerances, advantages of integrated approach over sequential approach. [08]

Module-IV

Generation of tool path: Simulation of machining processes, NC tool path generation, graphical implementation, determination of optimal index positions for executing fixed sequence, quantitative methods. Implementation techniques for CAPP: MIPLAN system, Computer programming languages tbr CAPP, criteria for selecting a CAPP system and benefits of CAPP. Computer integrated planning systems, and Capacity planning system. [12]

Text Book(s)

1. Automation, Production systems and Computer Integrated Manufacturing System, M P Groover.
2. Computer Aided Design and Manufacturing, Sadhu Singh.

Reference Book(s)

3. Computer Engineering, David Bedworth

Course Outcomes:

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

1. Develop process plan quickly for complex products with suitable machining parametrs.
2. Implement CAPP in an integrated manufacturing environment.

2. 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.

3. 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, GenisysXsprinter 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- C.C. Kai and L.K.Fai, World Scientific Co.
2. Rapid Prototyping & Manufacturing- Paul F. Jacobs, McGraw-Hill.
3. Rapid Prototyping- Andreas Gebhardt, Hanser Publishers.

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.

4. Mechanics of Composite Materials

Course Objectives:

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

1. Understand types and manufacturing of various composite materials.
2. Learn analytical concepts and strength estimation of structural composites.
3. Learn secondary processes and safety aspects of composites used for structures.

Module-I

Classification and constituents of composites, Interfaces and Interphases, Distribution of constituents. Fabrication of Metal Matrix Composites: Commonly used Matrices, Basic Requirements in Selection of constituents, solidification processing of composites - XD process, Spray processes - Osprey Process, Rapid solidification processing, Dispersion Processes - Stir-casting & Compocasting, Screw extrusion, Liquid metal impregnation Technique – Squeeze casting, Pressure infiltration, Lanxide process). Fabrication of Polymer Matrix Composites- Commonly used Matrices Basic Requirements inselection of Constituents, Moulding method, Low pressure closed moulding, pultrusion, Filament winding, Fabrication of ceramic matrix composites- Various techniques of vapour deposition, Liquid phase method and Hot pressing etc., Fabrication of nano-composites Characterisation Composites : Control of particle/fibre and porosity content, particle/fibre distribution, Interfacial Reaction of matrix-reinforcing component, Coating of reinforcing component. [10]

Module-II

Performance of Structural Composites: Combination effects (Summation, Complementation and Interaction), Basic analytical concepts (Qualitative black box approach and Quantitative analytical approach), Performance analysis by various models (Law of Mixtures, Shear lag model, Laminated plate model, Eshelby's models and Other models, - thermoelasticity, plasticity and creep), Strengthening mechanisms, Stress distribution in fibreand the matrix (shear stress and axial tensile stress in the fibre along its length), critical length of fibre for full strengthening, Analysis of uniaxial tensile stress-strain curve of unidirectional continuous and short fibre composites, Estimation of the required minimum amount of fibre and critical amount of fibre to gain a composite strength, Analysis of strength of a composite during loading at an angle to the fibres, Nano-structured composites Performance of Composite in Nonstructural Applications: Composites in Electrical, Superconducting andMagnetic Applications, Nano-composite devices. [12]

Module-III

Secondary Processing and Joining of Composite: Forging and extrusion of composites – critical issues, dynamic recovery and dynamic recrystallization, mechanical properties; Induction Heating, Fusion Bonding, Ultrasonic welding, Gas tungsten arc welding, Gas metal arc welding, Resistance spot & seam welding, Resistance brazing, Resistance spot joining, Resistant spot brazing, Resistance welding of thermoplastic graphite composite, Weld bonding, Brazing of MMC. Industrial Application of Composite Materials : Civil constructions of structures/pannels, Aerospace industries, Automobile and other surface transport industries, Packaging industries, House hold and sports components etc. [10]

Module-IV

Fracture & Safety of Composite : Fracture behaviour of composites, Mechanics and Weakest link statistics, Griffith theory of brittle fracture and modification for structural materials, Basic fracture mechanics of composite (Fracture toughness, COD and J-integral approaches, Fatigue crack growth rate), Fracture Mechanics of brittle matrix fibre composite, Fracture mechanics of metal matrix fibre composite, Experimental evaluation (composite), Elementaryreliability analysis. [08]

Text Book(s)

1. Composite materials, K.K. Chawala, Springer-Verlag.
2. Mechanics and Analysis of Composite Materials, V.V. Vasiliev and E.V. Morozov, Elsevier.

Reference Book(s)

1. Ceramic matrix composites, K.K. Chawala, Chapman & Hall, London.
2. Advances in composite materials, G. Piatti, Applied Science Publishers Ltd., London.
3. Nanocomposite Science and Technology, P. M. Ajayan, L. S. Schadler, P. V. Braun, Wiley.

Course Outcomes:

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

1. Select appropriate composite material for structural applications.
2. Suggest right combination and manufacturing process for composite materials for specific industrial use.
3. Conduct failure analysis of composite materials.

5. 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.

6. Design of Hydraulic and 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 flow control valves- relief valves, non-return and safety valves - actuation systems. [08]

Module-II

Reciprocation, quick return, sequencing, synchronizing circuits- accumulator circuits- industrial circuits- press circuits- 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- step counter method- compound circuit design- combination circuit design. [12]

Module-IV

Pneumatic equipment - selection of components - design calculations- application- fault finding- hydro pneumatic 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.

Sessional

CAM and Robotics Lab. (0-0-6)

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

1. Understand Features and selection of CNC machines.
2. Learn CNC programming for variety of products using APT language.
3. Learn robot programming and simulation of machining processes.

Features and selection of CNC turning and milling centers. Practice in part programming and operation of CNC turning machines, subroutine techniques and use of cycles. Practice in part programming and operating a machining center, tool Joining and selection of sequences of operations, tool setting on machine, practice in APT based NC programming.

Practice in Robot programming and its languages. Robotic simulation using software. Robot path control, preparation of various reports and route sheets.

Simulation of manufacturing system using CAM software, controller operating system commands.

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

1. Write part programs for NC machining
2. Program and control robot path for industrial applications.
3. Simulate manufacturing processes before being put to actual machining.