University of Pune

Faculty of Engineering
Board of Production and Industrial Engineering

Master of Engineering

Syllabus

for

Production - CAD / CAM Engineering

Effective from June 2013
## UNIVERSITY OF PUNE
### COURSE STRUCTURE FOR
#### M.E.CAD/CAM (2013 Course)

### Semester I

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture / Practical</td>
<td>Paper Assessment</td>
<td>TW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>In- Semester</td>
<td>End- Semester</td>
</tr>
<tr>
<td>511301</td>
<td>Computer aided design</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511302</td>
<td>Computer aided Manufacturing</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511303</td>
<td>Advanced Mathematics and Statistics</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511304</td>
<td>Design of Experiments &amp; Research Methodology</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511305</td>
<td>Elective I</td>
<td>5</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511306</td>
<td>Lab Practice I</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>25</td>
<td>250</td>
</tr>
</tbody>
</table>

### M.E. CAD/CAM (2013 Course)

### Semester II

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture / Practical</td>
<td>Paper Assessment</td>
<td>TW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>In- Semester</td>
<td>End- Semester</td>
</tr>
<tr>
<td>511307</td>
<td>Computer integrated manufacturing</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511308</td>
<td>Finite Element Analysis</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511309</td>
<td>Optimization Techniques</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511310</td>
<td>Elective II</td>
<td>5</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511311</td>
<td>Lab Practice II</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>511312</td>
<td>Seminar I</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Total</td>
<td>25</td>
<td>200</td>
</tr>
</tbody>
</table>
### M.E. CAD/CAM (2013 Course)

#### Semester III

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture / Practical</td>
<td>Paper</td>
<td>TW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>In-Semester</td>
<td>End-Semester</td>
</tr>
<tr>
<td>511313</td>
<td>Advanced Stress Analysis</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511314</td>
<td>Computer aided Production planning</td>
<td>4</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511315</td>
<td>Elective III</td>
<td>5</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>511316</td>
<td>Seminar II</td>
<td>4</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>511317</td>
<td>Project Work Stage I</td>
<td>8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>150</strong></td>
<td><strong>150</strong></td>
</tr>
</tbody>
</table>

#### M.E. CAD/CAM (2013 Course)

#### Semester IV

<table>
<thead>
<tr>
<th>Code</th>
<th>Subject</th>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Lecture / Practical</td>
<td>Paper</td>
<td>TW</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>In-Semester</td>
<td>End-Semester</td>
</tr>
<tr>
<td>511318</td>
<td>Seminar III</td>
<td>5</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>511319</td>
<td>Project Work Stage II</td>
<td>20</td>
<td>-</td>
<td>150</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>25</strong></td>
<td><strong>-</strong></td>
<td><strong>200</strong></td>
</tr>
</tbody>
</table>

#### Elective I
- a) Computational Fluid Dynamics
- b) Concurrent Product Design
- c) Industrial Robotics and Artificial Intelligence
- d) Advanced Mechatronics

#### Elective II
- a) Manufacturing System Design
- b) Rapid Prototyping
- c) Product Life Cycle Management
- d) CAD/CAM/CAE Software Development

#### Elective III (Open Elective)
- a) Tribology and Surface Engineering
- b) Advanced Material and Processing
- c) Energy Resource Management
- d) Quality and Reliability Engineering
511301 Computer Aided Design

Teaching Scheme
Lectures: 4 hrs/week
Credits: 4

Examination Scheme
In semester: 50
End semester: 50


2. Configuration of graphics workstations, Fundamentals of 2D graphics, Menu design and Graphical User Interface (GUI), Parametric Programming, Vector representation of geometric entities, Homogeneous coordinate systems, Geometric transformations.

3. Space Curve design - Analytical and Synthetic approaches, parametric equations, modeling of cubic spline, Bezier curve, B-spline curve and NURBS and their manipulation techniques.

4. Planes and surfaces design - Analytical and Synthetic approaches, parametric equations, modeling of biparametric Surfaces, Surfaces- Coons, Bezier, B-spline and NURBS patches, Surface manipulation techniques.

5. Geometric modeling techniques- Wireframes, B-Rep, CSG and Hybrid modelers, Feature based, Parametric and Variation modeling.

6. Virtual realism, computer animation, mechanical assembly and mass property calculations, CAD/CAM integration,

Text/ References:
511302 Computer Aided Manufacturing

Teaching Scheme
Lectures: 4hrs/week
Credits: 4

Examination Scheme
In semester: 50
End semester: 50

1. **Machine Centre**: Principles of Numerical control, Types of CNC Machine Tools, Features of CNC Systems, Direct numerical control (DNC), Elements of CNC viz. Ball screws, rolling guide ways, structure, drives and controls, standard controllers, Manual part programming with APT, Virtual machining. Machining Centers and Interpolators

2. **CNC Programming**: Types, Manual Part Programming, Canned Cycle, Offset, APT.

3. **Allied Machines**: CNC Presses, CNC-EDM, CNC-WEDM, CNC-CMM, CNC Molding Machines, Automated Welding.


REFERENCES:
6. Reference Manuals of FANUC, Siemens, Mazak, etc.
511303 Advanced Mathematics and Statistics

Teaching Scheme
Lectures: 4hrs/week
Credits: 4

Examination Scheme
In semester: 50
End semester: 50


4. Application of partial differential equations for solutions of
   1. One dimensional wave equation
   2. One dimensional heat conduction equation
   3. Laplace equation - with separation of variable method

5. Mathematical modeling: Proportion models, fitting models to data, creating simulations, dimensional analysis, probabilistic models optimization, discrete and continuous models, Monte Carlo simulation, efficiency improvement techniques, simulation output analysis.


References:
6. Mark Meerschaert, Mathematical modeling, Academic press
7. S. P. Gupta, Advanced statistical method
### 511304 Design of Experiments and Research Methodology

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures: 4 hrs/week</td>
<td>End semester: 50</td>
</tr>
<tr>
<td>Credits: 4</td>
<td>In semester: 50</td>
</tr>
</tbody>
</table>


**Reference Books:**

1. **Introduction:** CFD as the third dimension of fluid mechanics. Numerical Discretization methods such as Finite Difference, FEM and FVM, Why FVM as preferred method in CFD.


4. **Numerical Methods for Inviscid Flows:** Characteristic form of equations, Flux difference splitting, Application to 2-D flows such as flow through a nozzle

5. **Numerical methods for Incompressible flows:** The continuity equation divergence constraint, Poisson equation for pressure, Schemes such as SIMPLE due to Patankar and Spalding


**Reference Books**

511305 Elective I, b) Concurrent Product Design

Teaching Scheme
Lectures: 5 hrs/week
Credits: 5

Examination Scheme
In semester: 50
End semester: 50

1. Introduction: Types of design, importance of design, design considerations, product life cycle, technology life cycle, benchmarking and mass customization. Concurrent design team its elements.

2. Product Design Process: Steps in design, Functional requirement analysis, Axiomatic design, Product design specifications, concurrent design model

3. Material And Manufacturing Process Selection In Design: Factors influencing material and process selection, approaches, tools and software used in selection. Design For ‘X’: An introduction: Design for manufacturing, assembly and disassemble, an overview of DF’X’. Design for maintainability and serviceability, design for environment, design for aesthetic, design for packaging, design for handling, design for safety, etc.

4. Design Cost Estimation: Need, cost indexes, categories; cost-capacity factors; design to cost and life cycle costing.

5. Product Development Approaches: Concurrent engineering, partnership with supplier, collaborative and Internet based design. Design Project Management: PDM tools.

6. Introduction to VRML, modular product design, mechanical and electronic products design. Concurrent and collaborative product development case studies

Reference Books
511305 Elective I, c) Industrial Robotics and Artificial Intelligence

Teaching Scheme
Lectures: 5 hrs/week
Credits: 5

Examination Scheme
In semester: 50
End semester: 50

1. **Fundamentals of Industrial Robots:** Specifications and Characteristics, Basic components, configurations, Criteria for selection, Various industrial applications.

   **Robotic Control Systems:** Drives, Robot Motions, Actuators, Power transmission systems; Robot controllers, Dynamic properties of robots- stability, control resolution, spatial resolution, accuracy, repeatability, compliance.

2. **Robotic End Effectors and Sensors:** Transducers and sensors- sensors in robotics and their classification, Touch (Tactile) sensors, proximity and range sensors, force and torque sensing, End Effectors- Types, grippers, Various process tools as end effectors; Robot-End effectors interface, Active and passive compliance, Gripper selection and design.

3. **Robot Programming:** Lead through method, Robot program as a path in space, Methods of defining positions in space, Motion interpolation, branching; Textual robot programming languages

4. **Artificial Intelligence:** Concept of A.I., Approaches, Foundations of A.I., Problem Formulation: Problem solving agents, Components of problem definition, defining the problem as state space approach, Problem characteristics, Production System, searching for solutions, Forward and backward reasoning, means end analysis, Graphs and trees, measuring problem solving performance

5. **Search Strategies:** a) Uninformed (blind) search- breadth first, depth first, and their variations, avoiding repeated states; b) Informed (heuristic) search- heuristic function, Generate and test, Best first search, A* search, Local search algorithms- Hill climbing, Simulated annealing, Branch and bound and Local beam search.

6. **Knowledge Representation:** Simple rational knowledge, Inheritable knowledge, Inferential knowledge, Procedural knowledge, the Frame problem, Propositional logic- Syntax and semantics, well formed formulas (WFF), conversion to clausal form, using FOPL, inference rules, unification, non-deductive inference methods, resolution, forward and backward chaining, the knowledge engineering process, Handling uncertain knowledge, probability propositions.

**Reference Books:**


511305 Elective I, d) Advanced Mechatronics

Teaching Scheme
Lectures: 5 hrs/week
Credits: 5

Examination Scheme
In semester: 50
End semester: 50

1. Introduction
   Introduction to mechatronics system, evolution, scope and components of mechatronics systems, mechatronics in product and measurement system, control system and modes of control, traditional design and mechatronics design

2. Actuators, Sensors and Transducers
   Hydraulic, pneumatic and electrical actuators and their system modeling, performance terminology, system modeling of sensors; displacement, position and proximity sensors, velocity and acceleration sensors, flow sensors, force sensors, temperature sensors, ultrasonic and fibre-optic sensors, selection of sensor, piezo-electric sensors.

3. Hardware Components
   Number systems in Mechatronics, binary logic, Karnaugh map minimization, transducer signal conditioning process, principals of analogue and digital signal conditioning, protection, filtering, operational and instrumentation amplifiers and their gains, analogue to digital and digital to analogue conversion, multiplexers, pulse modulation.

4. Programmable Logic Controller
   Review of logic gates, basic structure, features, input/output processing, programming, functional block diagram (FBD), ladder diagram, logic functions, latching, sequencing, jumps, internal relays, counters, shift registers, master and jump control, data handling, data movement, data comparison, arithmetic operations, code conversion, analog input and output, applications for automation, diagnostics and condition monitoring.

5. Microcontroller
   Comparison between microprocessor and microcontroller, organization of microcontroller system, architecture of MCS 51 controller, pin diagram of 8051, addressing modes, programming of 8051, interfacing input and output devices, interfacing D/A converters and A/D converters, Various applications for automation and control purpose.

6. Advanced Applications in Mechatronics

Reference Books :
1. W. Bolton, Mechatronics 3/e, Pearson Education
2. Dan Necsulescu, Mechatronics, Pearson Education
10. David W. Pessen, Industrial Automation, John Wiley & Sons
12. Jack R. Hackworth & Fredrick D. Hackworth, Jr., Programmable Logic Controllers” Programming Methods and Applications (with CD Rom), Pearson Education
Each student should write at least two assignments on each theory subject studied in Semester I and conduct minimum Six experiments from the list given below as laboratory work.

1. 2D drawing and drafting using sketcher workbench – 2 drawings
2. 3D modeling and drafting using 3D features – 5 models
3. Assembling and drafting of 2 assemblies with interference checking.
4. Surface modeling – 4 exercises
5. CNC Lathe – 4 exercises
6. CNC Milling – 4 exercises
   - Generation of tool path, generation of NC code, Optimization of tool path
     (to reduce machining time) using any CAM software
7. Robot programming for any two industrial application.(e.g. pick and place, welding, painting etc.)
8. Minimum three programs on PLC for system automation involving of interfacing of sensors and actuators
9. Exercises on a total Mechatronics System Design for applications like packaging, loading/unloading, pick and place etc.
511307 Computer Integrated manufacturing

**Teaching Scheme**
- Lectures: 4 hrs/week
- Credits: 4

**Examination Scheme**
- In semester: 50
- End semester: 50

1. **Concept of CIM:** Introduction to CIM, Types of Manufacturing, CIM hardware and software, Elements of CIM, Product development through CIM

2. **CIM database:** Introduction, Database requirements of CIM, Database, Database management, Database Models, Product Data Management (PDM), Advantage of PDM.

3. **Work Cell:** Manufacturing cell, Group Technology, Cellular Manufacturing.

4. **Flexible Manufacturing System:** Introduction to FMS, Manufacturing integration model, flexible manufacturing strategy, Components of Flexible Manufacturing-Pallets and fixtures, machining centers, inspection equipment, material handling stations, storage system, In-process storage, manually operated stations, allied operation centers, FMS system design

5. **Robots in CIM:** Integration of the industrial robot into CIM system, product design of automatic manufacture of robots, computer aided inspection using robots.

6. **Networking in CIM:** Principles of networking, Network Techniques, Local area network (LAN), networking standards, Design Activities in a networked environment, networking in a manufacturing company, hardware elements of networking, Collaboration Engineering.

**References Book:**
2. Richard shover, An analysis of CAD/ CAM Application with introduction to C.I.M.
511308 Finite Element Analysis

Teaching Scheme
Lectures: 4 hrs/week
Credits: 4

Examination Scheme
In semester: 50
End semester: 50

1. **Introduction**: Structural analysis, objectives, static, Dynamic and kinematics analyses, Skeletal and continuum structures, modeling of infinite d.o.f. system into finite d.o.f system, Basic steps in finite element problems formulation, general applicability of the method.

2. **Element types and characteristics**: Discretization of the domain, Basic element shapes, Aspect ratio, shape function, generalized co-ordinates and nodal shape functions, 2d rectangular and triangular elements, Axisymmetric elements.

3. **Assembly of elements and matrices**: Concept of element assembly, Global and local coordinate system, band width and its effects, Banded and skyline assembly, Boundary conditions, solution of simultaneous equations, Guassian elimination methods, one and 2D applications Higher order and isoparametric elements

4. **One-Dimensional**: One dimensional quadratic and cubic element, Use of natural co-ordination system, area co-ordinate system continuity nad convergence requirements, 2D rectangular and triangular requirement

5. **Static analysis**: Analyses of trusses and frames, analyses of machine subassemblies, Use of commercial software packages, advantages and limitations

6. **Dynamic analysis**: Hamilton’s principle, derivation of equilibrium, consistent and lumpe mass matrices, Determination of natural frequencies and mode shapes, use of commercial software packages.

References Books:
511309 Optimization Techniques

Teaching Scheme
Lectures: 4 hrs/week
Credits: 4

Examination Scheme
In semester: 50
End semester: 50

1. **Classical Optimization Techniques:** Single-variable and Multi-variable Optimization, Hessian Matrix, Saddle Point, Lagrange Multipliers Method, Kuhn-Tucker Conditions


4. **Constrained Optimization Techniques:** Interior Penalty Function Method, Exterior Penalty Function Method

5. Genetic Algorithm, Simulated Annealing, Artificial Neural Networks

6. **Theory of Constraints:** Introduction to TOC, Optimized Production Technology (OPT), Nine principles of OPT, Five Focusing Steps (The 5FS) of TOC, Capacity Constrained Resources and the Time Buffer, Modeling the Time Buffer, Modeling Return-On-Investment (ROI) in TOC, Comparison of TOC and Local Optimization Approaches.

**Reference Books:**
511310 Elective II, a) Manufacturing Systems Design

Teaching Scheme
Lectures: 5hrs./week
Credits: 5

Examination Scheme
In Semester: 50
End Semester: 50

1. Fundamentals: System concept, Hierarchical structure, System design, Decision making procedure, System types in manufacturing environments; Manufacturing Systems: Structural aspects, transformational aspects, procedural aspects, integrated manufacturing systems; Modes of Production- Jobbing / Intermittent / Continuous; Mass Production- Economies of Scale, Optimum production scale, Mass Customization; Multi-Product Small Batch Production- Economies of Scope with Diversification; Logistic Systems- Material flow: conversion / transportation / storage


4. Information Systems in Manufacturing: Database structures, hierarchical, network, Relational-concepts, keys, relational operations, query languages; Shop Floor Data Collection Systems- Types of data, on-line and off-line data collection, Automatic data collection systems.


Reference Books:
511310 Elective II, b) Rapid Prototyping

Teaching Scheme
Lectures: 5 hrs. /week
Credits: 5

Examination Scheme
In semester: 50
End semester: 50


3. Prototype properties: Material properties, color, dimensional accuracy, stability, surface finish, machinability, environmental resistance, operational properties

4. RP Applications: Design, Concept Models, Form & fit checking, Ergonomic Studies, Functional testing, Requesting Price quotes, CAD data verification, Rapid Tooling, Rapid manufacturing, Science & Medicine, Archeology, Paleontology & forensic Science, miniaturization


REFERENCES
5. Rapid & Virtual Prototyping & applications, C. E. Bocking, AEW Rennie, Wiley Eastern
511310 Elective II, c) Product Life Cycle Management

Teaching Scheme
Lectures: 5 hrs./week
Credits: 5

Examination Scheme
In semester: 50
End semester: 50


2. **Product development process & Methodologies:** Integrated Product development process - Conceive – Specification, Concept design, Design - Detailed design, Validation and analysis (simulation), Tool design, Realize – Plan manufacturing, Manufacture, Build/Assemble, Test (quality check), Service - Sell and Deliver, Use, Maintain and Support, Dispose. Bottom-up design, Top-down design, Front loading design workflow, Design in context, Modular design. Concurrent engineering - work structuring and team Deployment - Product and process systemization - problem, identification and solving methodologies. Product Reliability, Mortality Curve. Design for Manufacturing, Design for Assembly. Design for Six Sigma.


5. **Product Data Management – (PDM Technology):** An Introduction to Concepts, Benefits and Terminology, CIM Data. PDM functions, definition and architectures of PDM systems, product data interchange, portal integration, PDM acquisition and implementation.

6. **Recent Advances:** Intelligent Information Systems - Knowledge based product and process models - Applications of soft computing in product development process - Advanced database design for integrated manufacturing.

**Reference Books:**
511310 Elective II, d) CAD/CAM/CAE Software Development

Teaching Scheme
Lectures: 5 hrs. /week
Credits: 5

Examination Scheme
In semester: 50
End semester: 50

1. **Introduction to Customization**: Customization, Application Programming Interface (API), macros, scripts.

2. **Tools for Customization**: Object Oriented Programming (OOP), OLE interfaces in CAD/CAM software, Use of general programming interfaces like VB, VBS, VC++, OpenGL programming

3. **System dependent programming interfaces**: Visual LISP (AutoCAD), GRIP (Unigraphics), Pro-Programming (Pro-Engineer), CATIA etc.

4. **Computer-based System Engineering**: System engineering process, Software product development life cycle, software processes, software development project management, software prototyping

5. **Rapid Development**: Core issues in rapid development, rapid development languages, life cycle planning and customer oriented development

6. **Automated Solid Modeling using Customization**: Creating 2D, 3D and solid entities through API, Editing 2D, 3D and solid entities through API, Design and development of user interfaces- icons, menus, dialog boxes, integrating databases with CAD, creating bill of material or parts list, automated assembly modeling through customization, automated drafting and dimensioning using customization, creating automated animations using API and animation software.

**Reference Books:**

1. Steve McConnel, Rapid Development, Microsoft Press
2. Ian Sommerville, Software Engineering, Pearson Education
5. George Omura, Advanced AutoCAD
6. ShyamTickoo, Customizing AutoCAD, Thomson Learning
7. ShyamTickoo, CATIA, Thomson Learning
8. MarttiMantilya, Solid Modelling, Computer Science Press
511311 Lab Practice II

Teaching Scheme                                    Examination Scheme
Practicals: 4 hrs. /week                           TW: 50
Credits: 4                                          Oral: 50

Each student should write at least two assignments on each theory subject studied in Semester II and conduct minimum Six experiments listed below as laboratory work.

1. Structural Analysis
2. Thermal Analysis
3. Fluid Flow Analysis
4. Coupled Field Analysis
5. Nodal Analysis
   • Minimum four problems shall be solved with hand calculations.
7. Co-ordinate Measuring Machine: Case study: Inspection of a component using different probes, generation of report and interface (for example – Gears, Housings, Flywheels, Walls of machine structure, etc.)
### 511312 Seminar I

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practicals: 4 hrs. /week</td>
<td>Term work: 50 Marks</td>
</tr>
<tr>
<td>Credits: 4</td>
<td>Oral: 50 Marks</td>
</tr>
</tbody>
</table>

Each student is required to deliver a Seminar on state of the art topic of his/her choice relevant to any area of CAD/CAM/CAE and submit it in the form of short report.
511313 Advanced Stress Analyses

Teaching Scheme
Lectures: 4 hrs./week
Credits: 4

Examination Scheme
In semester: 50
End semester: 50


2. Complex variable approach. Complex representation of stresses, displacements and applied boundary loads. Different methods of solution of 2-d problems for finite and infinite plates with simply and multiply connected regions.


5. Linear elastic fracture mechanics (LEFM), The pattern of stress and deformation near the tip of the crack. Determination of fracture toughness, Stress intensity factor, elastic plastic fracture mechanics, the size of the plastic zone, condition for the fracture, the energy release rate, sub-critical growth in reactive environment, crack extension behavior, Paris equation.

6. Fatigue and fracture safe designs, Investigation and analysis of failures, case studies in fatigue and fracture mechanics.

Reference Books:
511314 Computer Aided Production Planning

Teaching Scheme
Lectures: 4 hrs. /week
Credits: 4

Examination Scheme
In semester: 50
End semester: 50

1. **Computer Aided Forecasting**: Nature and use of forecast, sources of data, demand patterns, forecasting models, selection of forecasting technique, measurement of forecast accuracy, Adoptive methods.

   Computerized relative allocation of facility technique, automated layout design program and computerized relationship layout planning for facility location and layout.


4. **MRP**: Introduction, Objective, Input, Computational procedure, information provided by the system. Detailed capacity planning, manufacturing resources planning

   **ERP**: Introduction, main features, generic model of ERP system, selection of ERP, proof of concept approach, analytic hierarchy approach, ERP implementation.


6. Simulation - Major activities, purpose, simulation process, types methodology, simulation packages, process quality simulator, computer requirements trends, applications simulation of manufacturing systems.

Reference Books

1. An introduction to Automated Process Planning – Tien – Chien Chang and Richard Awysk/Prentice hall
2. M.P. Groover, Automation production systems and computer aided mfg.-
4. G.T. in the engineering industry Bur bridge
5. MRP – by Orlikey
6. Buffa&Sarin, Modern Production Management
7. P.B.Mahapatra, Computer Aided production management
8. Averill M Law & David Kelton, Simulation modeling and analysis, Tata Mcgraw Hill
511315 Elective III, a) Tribology and Surface Engineering (Open elective)

Teaching Scheme

| Lectures: 5hrs. /week | Credits: 5 |

Examination Scheme

| In semester: 50 |
| End semester: 50 |


4. Introduction to Surface Engineering: Concept and Scope of Surface Engineering, Mathematical modeling and manufacturing of surface layers, The solid surface-geometrical, mechanical and physico chemical concept, Three dimensional structure of surface, The superficial layer and its parameters.


6. Thin Layer Engineering Processes: Laser and electron beam hardening, its process parameters and their effects, Physical vapor deposition, Thermal evaporation Arc vaporization, Sputtering, Chemical vapor deposition, ion implantation technique, Coating of tools, TiC, TiN, Al2O3 and Diamond coating properties, applications of thin coatings.

Reference Books:
Teaching Scheme
Lectures: 5 hrs. /week
Credits: 5

Examination Scheme
In semester: 50
End semester: 50


6. Special processes and electronic fabrication: Principles, salient features, advantages and applications of abrasive floor machining, magnetic abrasive finishing, wire EDM, electrochemical grinding, honing, lapping and super finishing. Principles, elements, process, advantages, applications and surface preparation etc. of physical vapor deposition, chemical vapor deposition, electro less coating and thermal metal spraying.

Reference Books :
2. G.F.Benidict, “Advanced Manufacturing Processes”, Marcel Dekker Publisher
11. “Non Conventional Machining”, –Narosa Publishing House
511315 Elective III, c) Energy Resource Management (Open elective)

Teaching Scheme
Lectures: 5 hrs./week
Credits: 5

Examination Scheme
In semester: 50
End semester: 50


2. Energy Auditing: Methodology, analysis and reporting. Portable and on-line instruments, costing of utilities like steam, compressed air, electricity and water.


4. Electrical systems: Demand control, power factor improvement, benefits and ways of improvement. Load scheduling. Electric motors, losses, efficiency, energy-efficient motors, motor speed control, variable speed drive. Lighting: Illumination levels, fixtures, timers, energy efficient illumination.


Reference Books:
3. IGC Dryden, editor: The efficient use of Energy (Butterworths).
### 511315 Elective III, d)Quality and Reliability Engineering (Open elective)

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lectures: 5 hrs./week</td>
<td>In semester: 50</td>
</tr>
<tr>
<td>Credits: 5</td>
<td>End semester: 50</td>
</tr>
</tbody>
</table>

#### Quality Engineering

2. Steps in Robust Design, Quality Characteristics and Objective Functions, Control Factors and their Levels, Noise Factors and Testing Conditions, Planning and Conducting the Experiment


#### Reliability Engineering
4. The Reliability Function, Failure Rate, Hazard Rate, Bath-tub Curve, Relationship between Various Reliability Characteristics

   Component Reliability, Mean-time-to-failure, Time-dependent Hazard Models – Constant-hazard, Linear-hazard, Nonlinear-hazard and Gamma Models


6. Maintained Systems, Classification of Maintenance Activities: Breakdown, Preventive and Predictive Maintenance, Condition Monitoring, Maintainability and Availability, Reliability-centered Maintenance

#### Reference Books
### Syllabi 511316 Seminar II

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practicals: 4 hrs/week</td>
<td>Term works: 50 Marks</td>
</tr>
<tr>
<td>Credits: 4</td>
<td>Oral: 50 Marks</td>
</tr>
</tbody>
</table>

Each student is required to review the literature related to proposed dissertation work to be done. He/she is required to deliver the seminar and submit it in the form of short report.
### 511317 Project Stage I

<table>
<thead>
<tr>
<th>Teaching Scheme</th>
<th>Examination Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practicals: 8hrs/week</td>
<td>Term work: 50 Marks</td>
</tr>
<tr>
<td>Credits: 8</td>
<td>Oral: 50 Marks</td>
</tr>
</tbody>
</table>

Student has to submit a report based upon the following:
- Objective of the Project
- Problem statement
- Literature review
- Methodology
- Progress Achieved
- Difficulties encountered
- Experimental set up preparation
- Future plan of action
Teaching Scheme
Practicals: 5 hrs/week
Credits: 5

Examination Scheme
Term works: 50 Marks
Oral: 50 Marks

Each student is required to review the literature related to the dissertation work to be done, or on any other relevant topic. He/she is required to deliver the seminar and submit it in the form of short report.
511319 Project Stage II

**Teaching Scheme**
- **Practicals:** 20hrs/week
- **Credits:** 20

**Examination Scheme**
- **Term work:** 150 Marks
- **Oral:** 50 Marks

Student has to submit a report based upon the following:
1. Objectives of work
2. Review of literature
3. Development of methodology
4. Experimental and numerical analysis.
5. Results obtained.
6. Comparison of results with previous work done
7. Conclusions.