Syllabus

M.Tech in Mechanical Engineering
Specialization: Computer Integrated Manufacturing
# M.Tech. Programme
## Mechanical Engineering – Computer Integrated Manufacturing
### Curriculum and Scheme of Examinations (2013 Admission)

### SEMESTER I

<table>
<thead>
<tr>
<th>Code No.</th>
<th>Name of Subject</th>
<th>Credits</th>
<th>Hrs / week</th>
<th>End Sem Exam hours</th>
<th>Marks</th>
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<td>MCC 1004</td>
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<td>MCC 1006</td>
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<td><strong>360</strong></td>
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Of the 40 marks of internal Assessment, 25 marks for test and 15 marks for assignment. End sem exam is Conducted by the University.
<table>
<thead>
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<th>Code No.</th>
<th>Name of Subject</th>
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List of Stream Electives for Second Semester

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<tr>
<th>STREAM ELECTIVE I</th>
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<tbody>
<tr>
<td>MCE 2001 Mechatronics System Design</td>
<td>MCE 2007 Rapid Prototyping, Tooling And Manufacture</td>
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<tr>
<td>MCE 2002 Design For Manufacture and Assembly</td>
<td>MCE 2008 Computer Aided Process Planning And Control</td>
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<tr>
<td>MCE 2003 Modeling And Simulation of Manufacturing Systems</td>
<td>MCE 2009 Advanced Finite Element Analysis</td>
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<tr>
<td>MCE 2004 Precision Engineering</td>
<td>MCE 2010 Integrated Product Design &amp; Development</td>
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<td>MCE 2005 Advanced Manufacturing Planning and Control</td>
<td>MCE 2011 System Dynamics</td>
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<td>MCE 2006 Advanced Materials Removal Processes</td>
<td>MCE 2012 MEMS Modeling</td>
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List Of Department Electives** For Second Semester

1. MCD 2001 Principles of Robotics And Applications
2. MCD 2002 Computational Fluid Dynamics
3. MCD 2003 Tool and Die Design
4. MCD 2004 Information System For Manufacturing
5. MCD 2005 Total Quality Management
6. MCD 2006 Creative Engineering Design

SEMESTER III

<table>
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<th>Code No.</th>
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TOTAL = 14 23 - 320 180 500

5 hours of Departmental assistance work

Of the 40 marks of internal Assessment, 25marks for test and 15 marks for assignment End Sem Exam is conducted by the Individual Institutions

do

List of Stream Electives for Third Semester

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<thead>
<tr>
<th>STREAM ELECTIVE III</th>
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<tbody>
<tr>
<td>MCE 3001 Composite Material Technology</td>
<td>MCE 3005 Cellular Manufacturing Systems</td>
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<tr>
<td>MCE 3002 Statistical Process Control and Non Destructive Testing</td>
<td>MCE 3006 Lean Manufacturing</td>
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<td>MCE 3003 Meshless Methods</td>
<td>MCE 3007 Six Sigma</td>
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<td>MCE 3004 Hydraulics and Pneumatics</td>
<td>MCE 3008 Reliability Engineering and Total Productive Maintenance</td>
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List of Non- Department Electives** for Third Semester

1. MCI 3001 Artificial Intelligence In Cim
2. MCI 3002 Advanced Numerical techniques
3. MCI 3003 Nanotechnology
4. MCI 3004 Surface Engineering
<table>
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<tr>
<th>Code No</th>
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</table>
M.Tech in Mechanical Engineering
Specialization: Computer Integrated Manufacturing

SYLLABUS
SEMESTER I
MCM 1001 Applied Mathematical Modeling

Structure of the Course
Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
Make a mathematical model of a technical problem using ordinary or partial differential equations
Analyze the mathematical model using mathematical analysis
Implement a variety of problem-solving strategies.
Demonstrate the iterative techniques for the solution of linear algebraic systems
Demonstrate the concepts of numerical differentiation and integration
To study concepts and techniques in statistical methodology

Learning Outcomes
Apply problem-solving using techniques in differential equations and vector and tensor calculus in diverse situations in physics, engineering and other mathematical contexts.
Analyze the convergent properties of the iterative algorithms
Find the numerical approximation of the integrals
To design and conduct experiments, as well as to analyze and interpret data

Module 1

Module 2
Linear systems of algebraic equations. Gauss elimination, LU decomposition etc., Matrix inversion, ill-conditioned systems.
Numerical Eigen solution techniques (Power, Householder, QR methods etc.).
Numerical solution of systems of nonlinear algebraic equations; Newton-Raphson method.
Numerical integration: Newton-Cotes methods, error estimates, Gaussian quadrature.

Module 3
Numerical solution of ODEs: Euler, Adams, Runge-Kutta methods, and predictor-corrector procedures; Solution of PDEs: finite difference techniques.
Probability and Statistics – Probability Distribution, conditional probability, moment generating functions, Baye’s Theorem.
Testing of hypothesis, Tests for sample mean, difference of means single proportion, goodness of fit, testing of attributes

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCC 1002 CAD/CAM

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

To produce knowledgeable users of CAD systems.
Understand the various CAD/CAM and CNC processes.
To study advanced features of CAM
To understand the associativity between design and manufacturing

Learning Outcomes

To synthesize and apply the concepts learnt
Describe various operation in numerical control system and part programming
Describe CNC machining and interfaces of CAM and CNC
Undertake, under supervision, laboratory experiments to design in CAD and to program in CAM for machining

Module 1

2D and 3D transformation: - Translation, Scaling Rotation and Reflection- Projections parametric representation of Ellipse, Parabola, Hyperbola.

Module 2

CAD/CAM Data Exchange: Evaluation of data- exchange formats, IGES data representations and structure, STEP Architecture, implementation, ACIS & DXF.

Basic components of an NC system, classification, merits and demerits, applications, the cost of NC/CNC, dimensioning systems, axes designation, NC motion control, interpolation, part programming formats, manual part programming, NC words, codes cutter radius compensation, tool nose radius compensation, tool wear compensation, canned cycles, sub routines, do loop, mirroring features macro statements, application of NC to machine tools and other applications, NC coding systems (ISO and EIA)

Module 3

APT statements, programming, NC part programming using CAD/CAM, manual data input (MDI), engineering analysis of NC positioning systems, open loop and closed loop positioning systems, precision in NC positioning
Computer Numerical Control (CNC) and DNC: Features of CNC, Elements of CNC machines, the machine control unit for CNC, CNC software, direct numerical control, distributed numerical control
References:


Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCC 1003: Advanced Materials and Their Processing

Structure of the Course

Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives

This course provides knowledge in the areas Of Metallurgy, chemical Properties, heat treatment, advanced materials and selection of materials for important applications.

Learning Outcomes

To impart knowledge at an advanced level in advanced materials and their processing

Module 1


Module 2

Advanced metallic materials: Dual phase steels, Micro alloyed, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) steel, Maraging steel. Nanomaterials: Preparation of nano particles, synthesis, properties and applications of SiC, Alumina, Zirconia and nano crystalline materials,

Module 3


References:


Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCC 1004 Finite Element Analysis in Manufacturing

Structure of the Course

- Lecture: 3 hrs/Week
- Internal Continuous Assessment: 40 Marks
- End Semester Examination: 60 Marks

Course Objectives

Develop comprehensive knowledge in the fundamental mathematical and physical basis of FEM.

Know how to build FEM models of physical problems and apply appropriate constraints and boundary conditions along with external loads followed by an analysis.

Develop a complete FEM solution strategy for analysis of mechanical systems.

Learning Outcomes

- Students will be able to:
  - Explain the basic theoretical principles of the Finite Element method.
  - Employ industry-standard software for interactive FE model generation, analysis and the post-processing of results.
  - Formulate the boundary conditions of a problem in a suitable form for correct analysis.
  - Assess alternative strategies (of element type, mesh design, boundary condition definition etc.) for economical and accurate FE modeling of specific 2D, 3D and axisymmetric structural problems.

Module 1


Module 2


Module 3


References:


Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCC 1005 CNC Machine Tools

Structure of the Course

<table>
<thead>
<tr>
<th>Activity</th>
<th>Hours</th>
<th>Credits</th>
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<tbody>
<tr>
<td>Lecture</td>
<td>3 hrs/ Week</td>
<td>3</td>
</tr>
<tr>
<td>Internal Continuous Assessment</td>
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<td>40 Marks</td>
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<tr>
<td>End Semester Examination</td>
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<td>60 Marks</td>
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Course Objectives

This course makes students understand the emergence and development of numerical control machine, characteristics and application areas, master basic knowledge of transmission of machine, numerical control machine tool working principle and composition, master CNC machinery structure and nc machining system technology and equipment, understand all kinds of typical numerically-controlled machine tool, in order to adapt to the needs of the development of the modern industry.

Learning Outcomes

The students will be able to:

- Learn NC Programming (Manual and Computerised), Design and machine using CAD/CAM packages, Toolpaths Creations, Toolpath Verifications, Understand advanced features of CAD/CAM

Module 1

Development of CNC Technology (machines):- principles, features, advantages, economic benefits, applications, CNC, DNC concept.

Working principles of typical CNC lathes/turning centre, machining centre, CNC grinders, CNC press brakes, Laser cutting machines

Elements used to convert the rotary motion to a linear motion - Screw and nut, recirculating ball screw, planetary roller screw, recirculating roller screw, rack and pinion.

Linear motion guideways, magnetic slides, tool magazines, ATC, APC, chip conveyors, tool turrets. Tool holders, Work holding devices

Module 2

Torque transmission elements - gears, timing belts, flexible couplings, Bearings. Spindle bearings, Main Spindle design, Ball screw design and assembly principle, Linear slide design and assembly

Shunt motor, AC induction motor, Axis feed drives – stepper motor, servo motor, Encoder, Tachogenerators, sensors and other feedback device for CNC machines

Open loop and closed loop systems, microprocessor based CNC systems, block diagram of a typical CNC system, standard and optional features of a CNC control system, comparison of different control systems.

Module 3

Part Programming of a CNC Lathe: Axes definition, machine and workpiece datum, turret datum, absolute and incremental programming, G and M functions, tool offset information, tool nose radius compensation, long turning cycle, facing
cycle, constant cutting velocity, threading cycle, peck drilling cycle, part
programming examples.
Manual Part Programming of a Machining Centre: Co-ordinate systems, cutter
diameter compensation, fixed cycles- drilling cycle, tapping cycle, boring cycle,
part programming examples.

References:
3. David Gibbs and Thomas Crandall, CNC Machining and Programming: An
5. Kirloskar DC Servo Motors Catalogue, 1995. Use Siemens or Fanuc
servomotor manual
6. Programming Instruction Manuals of CNC Lathes and Machining Centres,
7. Korta, "Ball Screws" 1985..
Delhi, 1998.
10. Sadasivan, T.A. and Sarathy, D, "Cutting Tools for Productive Machining",
Widia (India) Ltd., August 1999.
Siemens or fanuc CNC programme manual

Structure of the Question paper
For the End Semester Examination the question paper will consist of three
questions from each module out of which two questions are to be answered by
the students
MCC 1006 Instrumentation and Control Systems

Structure of the Course

Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives:
To provide knowledge on the fundamentals of measurement science and measuring instruments
To provide a knowledge on the basics of control system theory

Learning Outcomes
Students will be conversant with measurement techniques and the use of measuring instruments
Students will have working knowledge for dealing with problems involving control system fundamentals

Module 1
Instrument classification, characteristics of instruments- static and dynamic, error analysis, systematic, and gross errors, statistical analysis. Different types of sensors and transducers, resistance, inductance, capacitance, piezoelectric, thermoelectric, photoelectric, strain gauges.

Module 2
Measurement of linear motion, velocity, acceleration, force, torque, strain, vibration, noise level, pressure, temperature, flow rate, humidity. Data acquisition systems, Virtual instrumentation, Condition monitoring.

Module 3.

References:
5. Katsuhiko Ogata., Modern control engineering, Prentice Hall Of India Pvt Ltd
6. Sahni, A.K., Mechanical and industrial measurements, Dhanpat Rai

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCC 1101 CAD/CAM LAB

Structure of the Course

Practical : 2 hrs/ Week Credits : 1
Internal Continuous Assessment : 100 Marks

Computer Aided Drafting , Geometric Modeling
Modeling and analysis using FEA software,
Manual and computer assisted part programming and Component manufacture in
machining centre/CNC Lathe
Simulation of Machining using CAM software

MCC 1102 Seminar

Structure of the Course

Seminar : 2 hrs/ Week Credits : 2
Internal Continuous Assessment : 100 Marks

The student is expected to present a seminar in one of the current topics in
Mechanical, Computer Integrated Manufacturing and related areas. The student will
under take a detailed study based on current published papers, journals, books on the
chosen subject and submit seminar report at the end of the semester.

Marks: Seminar Report Evaluation: 50
Seminar Presentation: 50
SEMESTER II
MCC2000: RESEARCH METHODOLOGY  2-0-0

Structure of the Course

Lecture: 2 hrs/ Week               Credits: 3
Internal Continuous Assessment : 40 Marks
End Semester Examination       : 60 Marks

Course Objectives

Academic research is a training to do an actual research. The objective of this course is to give an introduction to the methodology, methods and tools for doing a research work at academic level independently.

Learning Outcomes

Reading, understanding and interpreting the contents of a research paper published in a reputed journal in international level pertaining to the area of specialization.

Ability to summarize analyzes and interprets data. Ability to formulate and test hypothesis.

Module I

Introduction – meaning of research- objectives of research-motivation in research- types of research-research approaches – significance of research- research methods Vs methodology – criteria for good research

Defining research problem- what is a research problem- selecting the problem- necessity of defining the problem- literature review – importance of literature review in defining a problem- critical literature review – identifying gap areas from literature review

Module II

Research design–meaning of research design-need–features of good design- important concepts relating to research design- different types – developing a research plan

Method of data collection–collection of data- observation method- interview method-questionnaire method – processing and analyzing of data- processing options- types of analysis- interpretation of results

Module III

References

3. Day Ra “How to write and Publish a scientific paper”, Cambridge University Press 1989
5. Institute of Town Planners – India.
6. C.S. Yadav – City Planning – Administration & Participation
7. J.H. Ansari, Mahavir – ITPI Reading Material on Planning Techniques

Structure of the Question paper

For the End semester Examination There will be three questions from each module out of which two questions are to be answered by the students.
MCC 2001 COMPUTER INTEGRATED MANUFACTURING SYSTEMS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
Emphasizes the integration of manufacturing enterprise using computer-integrated manufacturing (CIM) technologies. It employs CAD/CAM interface and other CIM sub-systems, database management, facility layout, Group technology, teamwork, and manufacturing operations.

Learning Outcomes
Develop an understanding of computer-integrated manufacturing (CIM) and its impact on productivity, product cost, and quality.
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.
 Describe the integration of manufacturing activities into a complete system.

Module 1
Group technology-classification and coding, production flow analysis, machine cell design-simple examples in design, FAS-Different methods.
Machining centres and turning centres,workpiece handling systems,loading and unloading-fixtures and pallets,head indexers

Module 2
Distributed numerical control: DNC system – communication between DNC computer and machine control unit – hierarchical processing of data in DNC system – features of DNC system.
Adaptive control in Machine control unit.
Automated material handling: Function - types – analysis of material handling equipments,Design of AGV systems.
Tool Management system-tool strategies-tool identification technologies and tool monitoring, Inspection stations-CMM and non contact inspection

Module 3
Networking concepts, LOSI, MAP,TOP,LAN,WAN,Communication interface,bus architecture, topologies ,protocols.
Manufacturing data base-Process planning, CAPP, ERP modules.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCC 2002 COMPUTER AIDED INSPECTION

Structure of the Course
Lecture : 3 hrs/ Week               Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination        : 60 Marks

Course Objective:
To teach the basic concepts in various methods of engineering measurement techniques and applications, understand the importance of measurement and inspection in manufacturing industries.
Expose to various modern metrological instruments and the procedure used to operate these instruments.

Learning Outcome:
To give a thorough knowledge of measurement and instrumentation of increasing importance in industry.
The student will be knowledgeable in various standards and proliferation of computerized and automated inspecting techniques.

Module 1

Module 2
Co-ordinate measuring machine (CMM) – Contact type CMM – Configurations, parts and its features, types of probes, probe compensation. Non-Contact type CMM – Features, probes. Specifications.

Errors in CMM measurement – Calibration of CMM – measuring scales, accuracy – Moiré fringes – Applications of CMM for dimensional and form measurements.

Module 3

Reference:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCC 2101 CIM Lab

Structure of the Course

Practical : 2 hrs/ Week                Credits : 1
Internal Continuous Assessment : 100 Marks

Practice on Computer Aided Measuring Instruments
Image Processing ,PLC Controllers
Exposure to advanced CAM Packages.
Study on robotics, programming.
Study on FMS- Practice on Rapid Prototyping

MCC 2102 Thesis – Preliminary – Part 1

Structure of the Course

Thesis: 2 hrs/ Week                Credits : 2
Internal Continuous Assessment : 100 Marks

For the thesis- preliminary Part I the student is expected to start the preliminary background studies towards the Thesis by conducting a literature survey in the relevant field. He/ she should broadly identify the area of the thesis work, familiarize with the design and simulation tools required for the thesis work and plan the experimental platform, if any, required for the thesis work. The student should submit a detailed report of these activities at the end of the semester.

Evaluation of marks for the thesis preliminary part I
Evaluation of the thesis – preliminary work by the guide - 50 marks
Evaluation of the thesis – preliminary by the Evaluation Committee - 50 marks

MCC 2103 Seminar

Structure of the Course

Seminar : 2 hrs/ Week                Credits : 2
Internal Continuous Assessment : 100 Marks

The student is expected to present a seminar in one of the current topics in Mechanical, Computer Integrated Manufacturing and related areas. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester.

Marks: Seminar Report Evaluation: 50
        Seminar Presentation: 50
STREAM ELECTIVES
FOR
SECOND SEMESTER
STRUCTURE ELECTIVE I
MCE 2001 MECHATRONICS SYSTEM DESIGN

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives

Introduce the students the main components of mechatronics system design and principles, namely modelling of physical system, sensing components, actuating devices, signal and control, real-time interface.
Provide the knowledge of basic system elements and actuation, various system models, basic digital principles and system design.
It gives a framework of knowledge that allows engineers and technicians to develop an interdisciplinary understanding and integrated approach to engineering.

Learning Outcomes

Apply mechatronic concepts to actual problems encountered in engineering practice.

Module I

Module II
Actuators – Mechanical - Electrical - Fluid Power - Piezoelectric – Magnetostrictive - Shape memory alloy - applications - selection of actuators.
PROGRAMMABLE LOGIC CONTROLLERS:Introduction - Basic structure - Input and output processing - Programming - Mnemonics- Timers, counters and internal relays - Data handling - Selection of PLC.

Module III
DESIGN AND MECHATRONICS CASE STUDIES:
Designing - Possible design solutions-Traditional and Mechatronics design concepts - Case studies of Mechatronics systems - Pick and place Robot - Conveyor based material handling system - PC based CNC drilling machine – Mechatronics Control in automated Manufacturing – Data Acquisition Case studies.

References:

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCE 2002 DESIGN FOR MANUFACTURE AND ASSEMBLY

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To provide students with the knowledge, methodologies, and practice to optimize the
design of mechanical products for ease of assembly in manufacturing.
To analyze designs in terms of DFA and redesign to improve assembly.
To quantify and compare improvements in assembly resulting from design revisions.

Learning Outcomes
The student will be able :
To characterize and describe assembly, understand different assembly systems
that are in use today.
Utilize effective analysis, brainstorming, and trade-off techniques for
redesigning assemblies and subassemblies
To apply DFA principles to mechanical product design.
To design parts to facilitate assembly and to estimate rates of feeling and
orientation of small parts.

Module 1
Tolerancing: Geometric tolerances for manufacture as per Indian Standards and
ASME Y 14.5 standard, representation of surface finish. Limits and fits, tolerance
chains and identification of functionally important dimensions for applications.
Statistical tolerance indication in mechanical drawings, population parameter zone in
the $\mu$, $\sigma$ plane defined using $C_p$, $C_{pk}$.
Tolerance stack up analysis: Dimensional chain analysis-equivalent tolerances
method, equivalent standard tolerance grade method, equivalent influence method.

Selective assembly: Interchangeable part manufacture and selective assembly,
deciding the number of groups, group tolerances of mating parts.

Module 2
True position theory: Comparison between co-ordinate and convention method of
feature location, tolerancing and true position tolerancing, virtual size concept,
floating and fixed fasteners, projected tolerance zone, zero true position tolerance,
compound assembly
Automatic assembly: Transfer systems – Continuous and intermittent - Indexing
mechanisms. Methods for feeding, orienting and escapement for various forms of
parts. Case study: Vibratory feeder.
Design for Manufacture and Assembly (DFMA): DFMA as the tool for concurrent
engineering, DFMA criteria for retaining components for redesign of a product.
Tools for total design: Quality function deployment (QFD), failure modes and effects

Module 3
DFMA: General part design guidelines for manual assembly, development of
systematic Design for Assembly (DFA) methodology, assembly efficiency,
classification system for part handling, effect of various part features in handling and assembly. Typical case studies.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCE 2003 MODELING AND SIMULATION OF MANUFACTURING SYSTEMS

Structure of the Course

Lecture: 3 hrs/ Week  Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives

To understand the nature of discrete-event simulation and the types of simulation models
To understand the broad applicability of discrete-event simulation to solve complex manufacturing systems problems
To learn the essential steps of the simulation methodology
To gain insight into system behavior by measuring the performance characteristics of proposed new manufacturing systems or the impact of proposed changes for existing manufacturing systems

Learning Outcomes

Explain various methods of evaluating manufacturing system designs based on key performance measures.
Evaluate and interpret alternative system designs
Apply simulation modeling to an industrial problem, utilizing experimental design techniques.

Module 1

MANUFACTURING SYSTEMS AND MODELS: Types and principles of manufacturing systems, types and uses of manufacturing models, physical models, mathematical models, model uses, model building.

FLOW SHOP SYSTEMS: Assembly lines - reliable serial systems - approaches to line balancing - COMSOAL, ranked positional weight heuristic, branch and bound technique (optimal solution) - sequencing mixed models - unpaced lines, transfer lines and general serial systems - paced lines without buffers, two stage paced lines with buffers, introduction to unpaced lines.

Module 2

FLEXIBLE MANUFACTURING SYSTEMS: System components - planning and control hierarchy - system design, system setup, scheduling and control - flexible assembly systems.

CELLULAR SYSTEMS: Group technology - coding schemes - assigning machines to groups - production flow analysis, binary ordering algorithm, single pass heuristic, similarity coefficients, graph partition - assigning parts to machines.

JOB SHOP SYSTEMS: Facility layout- systematic layout planning, quadratic assignments problem approach - VNZ heuristic, branch and bound method - graph theoretical approach - decomposition of large facilities - net aisle and department layout.

Module 3
SUPPORTING COMPONENTS: Machine setup and operation sequencing – task assignment, task sequencing, integrated assignment and sequencing, material handling systems – conveyor analysis, AGV systems. Warehousing – storage and retrieval systems, order picking.

GENERIC MODELING APPROACHES: Queuing models – notations, performance measures, m/m/1 queue, m/m/m queue, batch arrival queuing systems, queues with breakdowns – queuing networks – open and closed networks, central server model.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCE 2004 PRECISION ENGINEERING

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To expose the students about the concepts of micro and precision manufacturing, the various processes involved in it and, the metrology of the micro and precision manufactured components

Learning Outcomes
Students will be able to
- Identify the distinguish elements of bulk micromachining and surface micromachining
- Describe the micromachining processes required to fabricate various MEMS devices.

Module 1
ACCURACY: Concept of accuracy – accuracy of numeric control systems, acceptance test for machine tools.

FACTORS AFFECTING ACCURACY: Static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influence on accuracy.

Module 2
MICRO FINISHING PROCESS: Surface roughness, bearing area curves, surface texture measurement, methods of improving accuracy and surface finish, finish boring, finish grinding, precision cylindrical grinding, micro machining, precision micro drilling.
BULK MICRO MACHINING AND NANO TECHNOLOGY: Wet etching, isotropic etching, anisotropic etching, dry etching, physical etching, reactive ion etching, Nano Technology, nano-grating system, nano-lithography, fabrication of CCDS, nano processing of materials for super high density ICs, nano-mechanical parts.

Module 3
MICRO ELECTRO MECHANICAL SYSTEMS: Introduction to silicon processing, wafer cleaning, diffusion and ion implantation, oxidation, photolithography, photo resist, resist strip, electron beam and X-ray lithography, thin film deposition, evaporation, sputtering, molecular beam epitaxy, chemical vapour deposition, electro plating.
UNCONVENTIONAL MACHINING: EDM machining, electro mechanical grinding, electron beam machining, laser beam machining, micro EDM and its applications, micro machining with laser

References:

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCE 2005 ADVANCED MANUFACTURING PLANNING AND CONTROL

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To introduce the student to a broad array of topics that fall under the umbrella of manufacturing planning and control; this includes an exposure to the terminology, concepts, principles, etc. associated with the area.
To develop a basic understanding of traditional planning techniques used by tactical and operational managers in real world organizations.
To introduce students to new approaches for planning and control

Learning Outcomes
Students will be able to understand the production information systems objectives and functionality, able to understand how manufacturing, MPS, PRP tables are processed.

Module 1
Resource Planning & Production Control: Overview of production control, Forecasting, Master production schedule, Materials requirements planning, Evolution from MRP to MRP II, Evaluation of MRP approach, Order release, Shop floor control.

Module 2
Just in Time (JIT) Production: Introduction- The spread of JIT movement, Some definitions of JIT, Core Japanese practices of JIT, Profit through cost reduction, Elimination of over production, Quality control, Quality assurance, Respect for humanity, Flexible work force, JIT production adapting to changing production quantities, Process layout for shortened lead times, Standardization of operation, automation.

Module 3
Toyota Production System (TPS): Philosophy of TPS, Basic frame work, Kanbans, Determining number of Kanbans in TPS
(a) Kanban number under constant quantity withdrawal system
(b) Constant cycle, Non-constant quantity withdrawal system
(c) Constant withdrawal cycle system for the supplier Kanban
Supplier Kanban and the sequence schedule for use by suppliers
(a) Later replenishment system by Kanban
(b) Sequence withdrawal system
Production smoothing in TPS, Production planning, Production smoothing, Adaptability to demand fluctuations, Sequencing method for the mixed model assembly line to realize smoothed production of goal.
References:
2. Yasuhiro Monden, Toyota production System-An Integrated Approach to Just in Time, CRC Press
6. Cheng, T.C., Podolsky, S., Just in Time Manufacturing, Springer

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCE 2006 ADVANCED MATERIAL REMOVAL PROCESSES

Structure of the Course
Lecture : 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives: To understand metal cutting and cutting tool materials, special machining processes, unconventional machining processes, micro machining processes.

Learning Outcomes: To impart knowledge in various fields of advanced manufacturing technology

Module I

Module II

Module III

Reference:
2. A. Bhattacharyya ,Metal Cutting Theory Practice New Central Book Agency (p) Ltd, Calcutta.
3. M.C. Shaw ,Metal Cutting Principles ,CBS Publishers
5. K.C. Jain & L.N. Agrawal ,Metal Cutting Science and Production Technology

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
STREAM ELECTIVE II

MCE 2007 RAPID PROTOTYPING, TOOLING AND MANUFACTURE

Structure of the Course
Lecture : 3 hrs/ Week            Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination     : 60 Marks

Course Objectives :
Generating a good understanding of RP history, its development and applications.
Expose the students to different types of Rapid prototyping processes, materials used in RP systems and reverse engineering.

Learning Outcomes
Student should be able to:
    Develop an understanding of the emerging technologies of rapid prototyping, rapid manufacturing and rapid tooling.
    Develop a degree of competency in the evaluation of various rapid manufacturing and rapid tooling technologies and their application in modern manufacturing processes

Module 1

Module 2
Solid Ground Curing (SGC): working principle, process, strengths, weaknesses and applications.

Module 3
Powder Based Rapid Prototyping Systems:
Other Rapid Prototyping Technologies:
Three Dimensional Printing (3DP):Principle, basic process, Physics of 3DP, types of printing, process capabilities, material system. Solid based, Liquid based and powder

Reference:

Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCE 2008 COMPUTER AIDED PROCESS PLANNING AND CONTROL

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To develop an understanding of the underlying knowledge and related methods of Computer Aided Process Planning.
To equip the students with the skills required in carrying out the process planning (PP) function in a computer integrated manufacturing environment

Learning Outcomes
Students will be able to
Implement Manual and Computer Aided Process Planning systems based on process planning criteria, and implementation and economic considerations
Describe the process planning functions, the role of process planning in manufacturing, the characteristics of traditional and Computer Aided Process Planning (CAPP) systems, and the structure of typical CAPP systems

Module 1
Introduction: The place of process planning in the manufacturing cycle - process planning and production planning – process planning and concurrent engineering, capp, group Technology.
Design drafting - dimensioning - conventional tolerance - geometric tolerance – geometric modelling for process planning.

Module 2
Process engineering and process planning: GT coding - the optiz system - the MICLASS system. Experienced, based planning - decision table and decision trees - process capability analysis - process planning - variant process planning - generative approach – forward and backward planning, input format, AI.

Module 3
Computer aided process planning systems: Logical design of a process planning - implementation considerations – manufacturing system components, production volume, no. of production families - CAM-I, CAPP, MIPLAN, APPAS, AUTOPLAN and PRO, CPPP.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCE 2009 ADVANCED FINITE ELEMENT ANALYSIS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course objective
To introduce advanced topics in FEA.
Emphasizes are on the mathematical foundations of the method, numerical algorithms
for software implementation, and analysis of problems with materials and geometric
nonlinear behavior. The course aims to investigate practical problems in detail

Learning Outcome
To perform complete FE formulations for engineering analysis
To write codes for a finite element model
To use commercial FEA software to solve engineering problems
To apply finite element methods in design engineering components or systems

Module 1
Bending Of Plates And Shells :Review of Elasticity Equations-Bending of Plates
and Shells-Finite Element Formulation of Plate and Shell Elements-Conforming and
Non Conforming Elements - Co and C1 Continuity Elements-Application and
Examples

Non-Linear Problems
Introduction-Iterative Techniques-Material non-Linearity-Elasto Plasticity-Plasticity-
Visco plasticity-Geometric Non linearity-large displacement Formulation-Application
in Metal Forming Process and contact problems

Module 2
Dynamic Problem
Direct Formulation - Free, Transient and Forced Response - Solution Procedures-
Subspace  Iterative Technique -Houbolt, Wilson, Newmark - Methods – Examples

Module 3
Fluid Mechanics And Heat Transfer
Governing Equations of Fluid Mechanics-Inviscid and Incompressible Flow-Potential
Formulations-Slow Non- Newtonian Flow-Metal and Polymer Forming-Navier
Stokes Equation-Steady and Transient Solutions.

Error Estimates And Adaptive Refinement
Error norms and Coverage rates- high refinement with adaptivity-Adaptive
refinement

References:
and Sons Inc., NewYork,1989
,1990

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions
from each module out of which two questions are to be answered by the students
MCE 2010 INTEGRATED PRODUCT DESIGN AND DEVELOPMENT

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
Become familiar with the IE techniques used in different stages of Product Lifecycle Management. To understand and to plan and implement the technical aspects of product development within a company

Learning Outcomes
The students should be able to know clearly the following:
Be able to get product specifications after discussions with the customers
Be able to get concepts from scratch and design a product using the specified procedures of product development.
Be able to cost for every stage of the product development, and look out for ways of minimizing them.

MODULE 1
Product Development Process And Organization
Introduction - Product Development in the changing global world- stages of product development – early design, detailed design, prototyping, manufacturing, servicing, discard /recycle
Product development organization – Concurrent engineering - Definition – CE Design Methodologies – CE organization – collaborative product development – Requirement definition- product requirement and definition

MODULE 2
Integration Of Product Development Phases
Product lifecycle – definition - Types of integration- file transfer, middle ware, and database

MODULE 3
Tools For Integration - IT enabled product development, Web based PDM architecture, CAD – PDM integration,
Integration approaches - feature based integration, Meta data based integration.
Internet Standards HTML,XML. Visualisation of CAD data, VRML

References
1. John W. Priest., Jose M. ,Product Development and design for manufacturing, Sanchez – Marcel Dekker Inc.

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To develop student’s skills in analyzing dynamic systems through the application of transient response analysis
To develop the student’s skills in proper modeling of mechanics to model mechanical, electrical and electromechanical systems
To introduce computational tools for the analysis of dynamic systems and the design and analysis of controllers

Learning Outcomes
Students will be able to create system equations for linear and rotary mechanical, electrical, hydraulic and thermal systems
Students should demonstrate mastery of first and second order system equations by, for example, forming transfer functions, relating the system’s response to pole location, identifying time constants and natural frequencies, and producing the response to various inputs
Students will be able to compute, plot and understand the frequency response of a system

Module 1

Control systems – Introduction –,Control system configurations – Control system Terminology – Control system classes – Feedback systems – Analysis of Feedback Historical Developments of control systems – Control system analysis and Design Objectives.

Module 2

Module 3
Stability of control systems – Routh-Hurwitz criterion – Steady state error – Control system types.
References

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCE 2012 MEMS MODELING

Structure of the Course
Lecture: 3 hrs/Week Credits: 3
Internal Continuous Assessment: 40 Marks
End Semester Examination: 60 Marks

Course Objectives
To understand the basic physics (and multi-physics) governing the behavior and response of MEMS.
To understand the operation of a wide range of sensors and actuators appropriate for microscale systems encompassing different energy domains.
To study a complete microsystem manufacturing cycle including design, modeling and fabrication.

Learning Outcomes
Students will be able to
Understand the micromachining techniques, including what they are, when to use them, and what needs to be considered when using them.
Demonstrate proficiency in designing process sequences.
Represent microsystems as generalized networks, suitable for design, analysis and simulation.

Module 1

Module 2
Fabrication Methods
Microfabrication Methods (VLSI Techniques), Positive and Negative Photoresists, Bulk Micromachining, Surface Micromachining, Etching (Isotropic and Anisotropic), Deposition techniques such as CVD (Chemical Vapor Deposition), Metallization Techniques, 3D High Aspect Ratio Techniques: LIGA, AMANDA, Microstereolithography, IH-Process, X-Ray Techniques, Ion-beam Lithography etc.


Module 3
Characterization Techniques, Topography Methods (Optical, Electrical and Mechanical Methods) Microscopy, STM (Scanning Tunneling Microscopes), SEM (Scanning Electron microscopes), SPM (Scanning Probe Microscopes), AFM (Atomic Force Microscopes)
Mechanical Structure Analysis
Deformation & Vibration Measurement Techniques (Piezo resistive and piezo electric), Interferometry Techniques, SPI (Speckle Pattern Interferometry), ESPI (Electronic Speckle Pattern Interferometry), Laser Techniques, Laser Doppler Vibrometers

Fluid, Thermal and Chemical Analysis

Thermal Analysis Techniques (Theoretical and Experimental), Fluid Flow Pattern Analysis, Electro-chemical Analysis, PIV Techniques, Spectroscopy

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
Department Electives

MCD 2001 PRINCIPLES OF ROBOTICS AND APPLICATIONS

Structure of the Course
Lecture : 3 hrs/ Week   Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objective:
To give the knowledge in Robot anatomy, end effectors, sensors, vision systems, kinematics, programming and the application of Artificial Intelligence in Robotics

Learning Outcome:
To provide advanced knowledge in the field of Industrial Robotics and the associated artificial intelligence

Module 1
Control System and Components: basic concept and modal, controllers control system analysis, robot activation and feedback components. Positions sensors, velocity sensors, actuators sensors, power transmission system.
Motion Analysis And Control: Manipulator kinematics, position representation forward transformation, homogeneous transformation, manipulator path control, robot dynamics, configuration of robot controller.

Module 2
End Effectors: Grippers-types, operation, mechanism, force analysis, tools as end effectors consideration in gripper selection and design.
Sensors: Desirable features, tactile, proximity and range sensors, uses sensors in robotics

Machine Vision, Functions, Sensing and Digitizing-imaging Devices

Robot Programming: Lead through programming, Robot programming as a path in space, Motion interpolation, WAIT, SINGNAL AND DELAY commands, Branching capabilities and Limitations

Module 3
Robot Languages: Textual robot languages, Generation, Robot language structures, Elements in function
Recent Trends In Robotics: Multi-axis robots, intelligent robots.

Reference Books:
1. Saeed B Niku., Introduction to Robotics Analysis, Systems, Applications, PHI.

Structure of the Question paper

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCD 2002 COMPUTATIONAL FLUID DYNAMICS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To introduce the basic principles in computational fluid dynamics
To develop methodologies which facilitate the application of the subject to practical problems

Learning Outcomes
Students will be able to
- Build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modelling etc.) in using commercial CFD codes
- Gain experience in the application of CFD analysis to real engineering designs.

Module 1
INTRODUCTION: Basics of fluid flow, derivation of the governing equations - conservation of mass, momentum and energy.

GRID GENERATION: Choice of grid, grid oriented velocity components, cartesian velocity components, staggered and collocated arrangements, adaptive grids.

DISCRETISATION: Finite difference method, forward, backward and central difference schemes, explicit and implicit methods. Properties of numerical solution methods, stability analysis, error estimation.

Module 2
CFD TECHNIQUES: Mathematical classification of flow, hyperbolic, parabolic, elliptic and mixed flow types, Lax - Wendroff technique, MacCormack’s technique, relaxation technique, artificial viscosity, ADI technique, pressure correction technique, SIMPLE algorithm, upwind schemes, flux vector splitting.

Module 3
FINITE VOLUME METHOD: Introduction, difference between FDM and FVM, approximation of surface integrals, approximation of volume integrals, interpolation practices, implementation of boundary conditions.

TURBULENCE MODELING: Turbulence energy equation- one-equation model, the k-ω model, the k- ε model.
APPLICATIONS: Fluid dynamics and heat transfer problems.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCD 2003 TOOL AND DIE DESIGN

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives:
This course provides knowledge in the areas of design of single point and multi point cutting tools, dies, jigs, fixtures and limit gauges and toll design for CNC machines.

Learning Outcome:
To impart in depth knowledge in various fields of tool engineering.

Module 1
Cutting Tool Design :Fundamentals of Cutting tools design, cutting tools and their principal elements, Tool geometry, system of nomenclatures and their interrelations, setting for the grinding of various basic cutting tool (turning, drilling, milling)
Analyses and Design of Jigs and Fixture : Principles of jig and fixture design, Dual cylinder location, diamond pin analysis, V-block analysis, design principles of centralizes, various mechanisms and design of equalizers, analysis for optimum number of clamping forces required and calculation of their magnitudes, concept of modular fixtures, design of fixtures for NC/CNC machines, computer applications in fixture design and analysis.

Module 2
Design of forging dies: Grain flow considerations, parting line selection, draft, design problems involving ribs, bosses and fillets. Flash and flash control, determination of number of impressions required and their sequence, design steps and analysis of forging dies, detail calculations, shrinkage, cavity shapes, heat transfer considerations, cooling and ejection systems, automation in forging operations, computer aided design and analysis.

Module 3
Design of injection molds :Principles of melt processing, product considerations, determination of economical number of cavities, temperature control of injection molds, calculation of mold opening force and ejection force. Detail design of cooling system, ejection system and gating system. Mold ability features, mold flow analysis.
Die casting die design : Metals for die casting, specific details of die construction, casting ejectors, side cores, loose die pieces, slides, types of cores, directional solidification, types of feeders, die venting, water cooling, design aspects of die casting dies, defects.

References
3. ASTEM: “Fundamentals of Tool Design”

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCD 2004 INFORMATION SYSTEM FOR MANUFACTURING

Structure of the Course
Lecture : 3 hrs/ Week          Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
The course provides students a fundamental understanding of management information systems concepts and their role in contemporary business.
To understand the various types of computer-based information systems used in organizations, when each is appropriate, the technology required to implement each system, and the types of system development approaches that should be used.

Learning Outcomes
Understand the components and types of computer-based information systems.
Describe the role of information systems in decision making.
Develop an understanding of how various information systems work together to accomplish the information objectives of an organization.

Module 1

Module 2

Module 3
Manufacturing consideration and Information system for manufacturing: 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.
Parts oriented production information system - concepts and structure - computerized production scheduling, online production control systems, computer based production management system, computerized manufacturing information system - case study.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCD 2005 TOTAL QUALITY MANAGEMENT

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To teach the concept of Total Quality Management applied in different organizations, Quality and Quality Standards followed by such entities and the implications of applying the Statistical Process Control Techniques to measure Quality products and services.

Learning Outcomes
Adopt TQM as a fundamental business strategy
Communicate the importance of customer focused TQM

Module 1
FOUNDATIONS OF TQM: Understanding quality, quality, competitiveness and customers, building quality chains, managing quality, quality in all functions, models and frame works for total quality management, Early TQM frameworks – quality award models – the four Ps and three Cs of TQM - a new model for TQM.

LEADERSHIP AND COMMITMENT: The TQM approach – commitment and policy – creating or changing the culture – effective leadership – excellence in leadership.
DESIGN FOR QUALITY: Design, innovation and improvement – the design process – quality function deployment (QFD) – the house of quality – specifications and standards - design in the service sectors – failure mode effect and criticality analysis (FMECA) – The links between good design and managing the business.

PROCESS REDESIGN / ENGINEERING: Reengineering the organization - process for redesign - the redesign process – the people and the leaders.

Module 2
HUMAN RESOURCE MANAGEMENT: Introduction – strategic alignment of HRM policies – effective communication – employee empowerment and involvement – training and development – teams and team work – review, continuous improvement and conclusions – organizing people for quality – quality circles or kaizen teams.

COMMUNICATIONS, INNOVATION AND LEARNING: Communicating the quality strategy - communicating the quality message – communication, learning, education and training – a systematic approach to education and training for quality – turning educations and training into learning – the practicalities of sharing knowledge and learning.

Module 3
IMPLEMENTING TQM: TQM and the management of change – planning the implementation of TQM – sustained improvement.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To enhance critical thinking and design skills.
To introduce students a broad view of engineering analysis and design,
To reinforce the importance of mathematics and science in engineering design and analysis,
Offer experience in hands-on, creative engineering projects.

Learning Outcomes
Understand the design of systems, components, and processes to meet desired needs within realistic constraints.
Develop early abilities in identifying, formulating, and solving engineering problems

Module 1
Introduction: Example of different kinds of designs and designers, Good and bad designs, Design problems, Definition of Design, engineering design and design research, Importance.
Product life cycle, Morphology of design, Introduction to system design process, Stage models.
Introduction to Task Clarification: overall process and steps Methods for Data collection and collation including patent analysis.

Module 2
Methods for identification of requirements: Role Playing, Checklists, Solution neutral problem statements, Quantifying requirements and Assigning importance to requirements.
Linking Customer requirements to engineering requirements: Quality Function Deployment techniques.
Introduction to conceptual design: Identification of functions, Ideation, Simulation and Consolidation into solution proposals.

Module 3
Methods for Identification of functions - functional decomposition techniques, Methods for Ideation- Brainstorming, Synectics.
Methods for consolidation into solution proposals- Morphological charts, Morphological matrix, Methods for simulation: analytical, virtual and physical Simulations.
Methods for improvement of solution proposals- contradiction analysis, various other TRIZ techniques, Systematic evaluation of concepts: ordinal methods and cardinal methods.

References:
2. Cross, N. Engineering Design Methods: Strategies for Product Design (4th edition), John Wiley and Sons Ltd., Chichester
4. Jones, J.C. Design Methods, 2nd Edition, John Wiley and Sons Ltd., Chichester

**Structure of the Question paper**
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
SEMESTER III

MCC 3101 Thesis Preliminary Part II

Structure of the Course

Thesis: 14 hrs/ Week
Credits: 5
Internal Continuous Assessment: 200 Marks

The student has to continue the thesis work identified in the Second semester. The student has to present two seminars and submit an interim thesis report.

Evaluation of marks for the thesis preliminary part II
Evaluation of the thesis – preliminary work by the guide - 100 marks
Evaluation of the thesis – preliminary by the Evaluation Committee - 100 marks
Stream Electives Offered For Third Semester
STREAM ELECTIVE III
MCE 3001 COMPOSITE MATERIAL TECHNOLOGY

Structure of the Course

Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To develop an understanding of the linear elastic analysis of composite materials.
To predict/interpret the behaviour and properties of composites as a function of their composition and manufacturing conditions
To provide an understanding of many important design, manufacture and performance issues of concern in current applications of composite materials

Learning Outcomes
Students will be able to
- Suggest solutions for a wide variety of simple composite design/manufacture performance issues.
- Analyze a laminated plate in bending, including finding laminate properties from lamina properties and find residual stresses from curing and moisture.
- Predict the failure strength of a laminated composite plate

Module 1
INTRODUCTION: Characteristics of composite materials, classification of composites, advantages, applications. Matrix and their role, principal types of fibre and matrix materials, basic principles of production of composite materials and products, advantages and limitations of different processes.

MICRO MECHANICAL BEHAVIOUR OF A LAMINA: Volume and mass fractions, evaluation of elastic moduli, strength of unidirectional lamina, multiaxial strength criteria, analysis of discontinuous fiber lamina.

Module 2
MACRO MECHANICAL BEHAVIOUR OF A LAMINA: Hooke's law for different types of materials, engineering constants for orthotropic materials. Stress, strain relations for plane stress in an orthotropic materials and in a lamina of arbitrary orientation, strength of an orthotropic lamina, basic strength theories, determinations of engineering constants, mechanics of materials approach.
MACRO MECHANICAL BEHAVIOUR OF A LAMINATE: Classical lamination theory, lamina stress, strain behaviour, resultant forces and moments in a laminate, types of laminates, strength and stiffness of laminates, interlaminar stresses in laminates.

Module 3
LAMINATED PLATES AND BEAMS: Types of laminated plates and beams, elementary mechanical behaviour, bending and buckling of laminated plates, forces and moments, stresses and deflections under different boundary conditions.
MANUFACTURE OF COMPOSITE COMPONENTS: Lay up and curing, open and closed mould processes, hand lay up techniques, bag moulding, filament winding, pultrusion, pulforming, thermoforming, injections moulding, blow moulding. Manufacture of metal matrix composites and ceramic matrix composites.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCE 3002 STATISTICAL PROCESS CONTROL AND NON DESTRUCTIVE TESTING

Structure of the Course
Lecture : 3 hrs/ Week  Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives:
The students are expected to understand the general issues and applications of Statistical Process Control and Non Destructive Testing.

Learning Outcome:
To appreciate the students with the background, applications and current status of Statistical Process Control and Non Destructive Testing.

Module 1
STATISTICAL QUALITY CONTROL: Methods and Philosophy of Statistical Process Control - Control Charts for Variables and Attributes - Cumulative sum and Exponentially weighted moving average control charts - Others SPC Techniques – Process - Capability Analysis - Six sigma accuracy.
ACCEPTANCE SAMPLING: Acceptance Sampling Problem - Single Sampling Plans for attributes - double,multiple and sequential sampling, The Dodge - Roming sampling plans – Military standards.

Module 2
LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS:
RADIOGRAPHY:
Sources of ray-x-ray production - properties of d and x rays - film characteristics - exposure charts - contrasts - operational characteristics of x ray equipment - applications.

Module 3

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCE 3003 MESHLESS METHODS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To learn the definitions and understand the key concepts of multivariate scattered data approximation with radial basis functions and moving least squares methods.
To learn direct and iterative algorithms to solve multivariate interpolation and least squares approximation problems.
To apply these methods to the solution of partial differential equations.

Learning Outcomes
Students will be able to
Learn meshfree method types, meshfree shape functions, weak form types
Have the ability to be able to solve problems by using meshfree methods
to solve a problem by writing a computer code containing meshfree method

Module 1
Fundamental of Continuum Mechanics :Kinematics ,Basic Laws of Motion, Constitutive Theory, Thermoviscoelastic Solid and Special Cases
Overview on Meshless Methods and Their Applications: Approximation Function, Numerical Implementation,Applications

Module 2
Procedures of Meshless Methods:
Construction of the Approximation, Choice of Weight Function, Formulation of Meshless Analysis, Evaluation of the Integral, Treatment of Discontinuity, Treatment of Mirror Symmetry, H- and P-Refinements,
Meshless Analysis of Elastic Problems: Background Theory for Applications of Elastostatics, Meshless Analysis of Elastostatic Problems , General Dynamic Problems, Meshless Analysis of Elastodynamic Problems, Meshless Analysis of Multiphase Materials

Module 3
Meshless Analysis of High-Speed Impact/Contact Problem, Incremental Plasticity and Slow Crack Growth Problem.

References:
1. G.R Liu, Meshfree Methods: Moving beyond the Finite element method, CRC press

**Structure of the Question paper**
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCE 3004 HYDRAULIC AND PNEUMATICS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Course Objectives
To understand the basic components and functions of hydraulic and pneumatic systems, compare hydraulics and pneumatics to each other in terms of technical performance

Learning Outcomes
Upon completion, the students will demonstrate an understanding of Hydraulic and Pneumatic principles, equipment, Seals and industries, will be able to identify and describe the basic operation of Hydraulic / Pneumatic systems, the various equipment used in their operation, Hydraulic / Pneumatic terms as well as actuator Sealing Device design / material strengths and weaknesses, will be able to troubleshoot Hydraulic / Pneumatic equipment and Seals

Module 1
Introduction to oil hydraulics and pneumatics, their advantages and limitations. ISO Symbols and standards in Oil Hydraulics and Pneumatics. Recent developments, applications Basic types and constructions of Hydraulic pumps and motors. Ideal pump and motor analysis. Practical pump and motor analysis. Performance curves and parameters.
Hydraulic control elements – direction, pressure and flow control valves. Valve configurations, General valve analysis, valve lap, flow forces and lateral forces on spool valves. Series and parallel pressure compensation flow control valves.

Module 2

Module 3
Use of Displacement – Time and Travel-Step diagrams; Synchronization circuits and accumulator sizing. Meter-in, Meter-out and Bleed-off circuits; Fail Safe and Counter balancing circuits.
Components of a pneumatic system; Direction, flow and pressure control valves in pneumatic systems. Development of single and multiple actuator circuits; Valves for logic functions; Time delay valve; Exhaust and supply air throttling; Examples of typical circuits using Displacement – Time and Travel-Step diagrams. Will-dependent control, Travel dependent control and Time-dependent control, Combined Control, Program Control, Sequence Control, Electro-pneumatic control and air-hydraulic control. Applications in Assembly, Feeding, Metalworking, materials handling and plastics working.
References
7. Khaimovitch : Hydraulic and Pneumatic control of machine tools
8. Merrit : Hydraulic control systems

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
STREAM ELECTIVE IV
MCE 3005 CELLULAR MANUFACTURING SYSTEMS

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination         : 60 Marks

Courses Objective:
To understand the Concepts and applications of Cellular manufacturing systems,Traditional and non-traditional approaches of Problem solving, Performance measurement, Human and economical aspects of CMS.

Learning Outcome:
To impart knowledge on group technology, optimization algorithms, implementation of GT/CMS, Performance measurements and economical aspects of CMS.

Module 1
Introduction to Group Technology, Limitations of traditional manufacturing systems, characteristics and design of groups, benefits of GT and issues in GT.

Module 2
Inter and Intra cell layout, cost and non-cost based models, establishing a team approach, Managerial structure and groups, batch sequencing and sizing, life cycle issues in GT/CMS.

Module 3
Economics Of Gt/Cms: Conventional Vs group use of computer models in GT/CMS, Human aspects of GT/CMS - cases.

References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students
MCE 3006 LEAN MANUFACTURING

Structure of the Course
Lecture: 3 hrs/ Week Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
Identify manufacturing system waste Understand the roles of employees and managers, supply chain issues, pre-automation, autonomaion and automation as they apply to lean manufacturing

Learning Outcomes
Understand workplace organization and visual manufacturing tools Understand and apply value stream mapping concepts Understand the idea about pull production and maintenance system

Module 1
Lean manufacturing: Basics, principles & elements
Small-lot production: Lot-size basics; lot sizing; lot-size reduction; facilitating small lot size.
Setup-Time reduction: Setup reduction methodology; techniques for setup-reduction; setup reduction projects.
Pull production systems: Pull systems and push systems; conditions for pull production systems; how to achieve pull production; mechanisms for signal and control.

Module 2
Work cells and cellular manufacturing: Cell layout and capacity measures; design of workcells; worker assignment; implementation issues.
Scheduling for smooth flow: Production leveling; level scheduling in pull production; master production scheduling.
Synchronizing and balancing process: Synchronisation; bottleneck scheduling; balancing; adapting to schedule changes.

Module 3
Planning and control in pull production: Centralized planning and control system; decentralized planning and control system; adapting MRP-based production planning and control system to pull production
Maintaining and improving equipment: Equipment maintenance; equipment effectiveness; total productive maintenance.

References:

**Structure of the Question paper**

For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCE 3007 SIX SIGMA

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To demonstrate a good understanding of the numerous techniques, tools and methodologies used in Six Sigma
To apply the principles of Six Sigma as used in Engineering and Asset Management
To appreciate the utilisation of Quality/Six Sigma /Lean throughout the total life cycle of the Manufacturing or Asset Management processes
To use Sigma Tools to eliminate waste in Production

Learning Outcomes
Students will be able to
   Get knowledge and experience of the stages of Six Sigma - the structured DMAIC methodology
   Lead and execute process-level improvement projects
   Collect process data and develop process maps
   Develop statistical hypotheses using simple statistical tools

Module 1
INTRODUCTION: Overview , six sigma defined – background – six sigma compared to total quality management – transactional vs. Manufacturing six sigma – common terms, foundations of lean six sigma – the four keys, five laws of lean six sigma.

PREPARATION PHASE: Organizational success factors – leadership, six sigma as strategic initiative, internal communication strategy and tactics, formal launch, organizational structure, six sigma training plan, project selection, assessing organizational readiness, pitfalls. work as a process – vertical functions and horizontal processes. Voice of customer – importance, collect voc data, critical to quality customer requirements. project management – challenges, culture, project management processes, team typing, team stages, characteristics of effective teams.

Module 2
DEFINE PHASE: DMAIC phases, overview, project charter – voice of the customer – high level process map– project team – case study.


Module 3
scorecard – failure mode and effects analysis – SPC charts, final project report and documentation.


References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
MCE 3008 RELIABILITY ENGINEERING AND TOTAL PRODUCTIVE MAINTENANCE

Structure of the Course
Lecture : 3 hrs/ Week                Credits : 3
Internal Continuous Assessment : 40 Marks
End Semester Examination : 60 Marks

Course Objectives
To empower with the skills to manage a manufacturing system to achieve continuous system availability for production
To develop ability in formulating suitable maintenance strategies to achieve reliable a manufacturing system
To equip with essential system diagnosis techniques so that you can identify and take appropriate actions on error symptoms and causes of failures

Learning Outcomes
Students will be able to
      Understand the relationship of key concepts in reliability engineering and application to maintenance strategies in a manufacturing environment
      Establish maintenance strategies according to system characteristics and design transition programs to implement these strategies
      Manage the manufacturing organisation with highest possible availability

Module 1
INTRODUCTION: Definitions, stage gate approach, reliability mathematics, reliability models, parametric and catastrophic methods, reliability predictive modelling.

FAILURE MODES AND EFFECT ANALYSIS: Goal and vision, concepts and types of FMEA evaluations, fault tree model.

Module 2
EVALUATING PRODUCT RISK: Test design by failure modes and aging stresses. Aging due to cyclic force, Miner’s rule.

CONCEPTS IN ACCELERATED TESTING: Time acceleration factor, influence of acceleration factor in test planning, application to acceleration test, high temperature operating life acceleration model, temperature humidity bias acceleration model, temperature cycle acceleration model, vibration accelerator model, failure free accelerated test planning. Accelerated reliability growth.

Module 3
PRODUCT MAINTAINABILITY: Maintainability concepts and analysis measures of maintainability, design for serviceability, supportability and maintainability preventive maintenance scheduling.
INTRODUCTION TO SOFTWARE RELIABILITY: Definitions, waterfall lifecycle, techniques to improve software reliability, software reliability models.
References:

Structure of the Question paper
For the End Semester Examination the question paper will consist of three questions from each module out of which two questions are to be answered by the students.
SEMIESTER IV

MCC 4101 THESIS

Structure of the Course
Thesis : 21 hrs/ Week         Credits : 12
Internal Continuous Assessment : 300 Marks
Thesis Evaluation + Viva-Voce  : 300 Marks

The student has to continue the thesis work identified in the Second semester. There shall be two seminars (a mid term evaluation on the progress of the work and the pre submission seminar to assess the quality and quantum of the work). At least one technical paper is to be prepared for possible publication in journals / conferences. The final evaluation of the thesis shall be an external evaluation. The marks for the Thesis-Final may be proportionally distributed between external and internal evaluation as follows.

Distribution of marks allotted for the Thesis

Internal evaluation of the thesis work by the guide - 150 marks
Internal evaluation of the thesis by the evaluation committee - 150 marks
Final evaluation of the thesis work by internal and External examiners :
(Evaluation of Thesis :200 marks + Viva voce :100 marks) – 300 Marks