Curriculum and Syllabus for

M.E. CAD/CAM

Revision 0

REGULATIONS 2014
<table>
<thead>
<tr>
<th>Action</th>
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<tbody>
<tr>
<td>Designed and Developed by</td>
<td>BoS CAD/CAM</td>
<td>[Signature: P. Bhavikiran]</td>
</tr>
<tr>
<td>Compiled by</td>
<td>Office of COE</td>
<td>[Signature: PSR]</td>
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<tr>
<td>Approved by</td>
<td>Principal</td>
<td>[Signature: A. Bhatnagar]</td>
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## Semester I

<table>
<thead>
<tr>
<th>Course Code</th>
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**Total Credits: 69**

### LIST OF ELECTIVES

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AIM:
To develop analytical capability and to impart knowledge in Mathematical and Numerical methods and their applications in Engineering and Technology and to apply these concepts in engineering problems they would come across.

OBJECTIVES:
- At the end of the course, students should be able to understand Mathematical and Numerical methods concepts and apply the concepts in solving the engineering problems.

UNIT I SIMULTANEOUS EQUATIONS AND NUMERICAL INTEGRATION 10+3

UNIT II BOUNDARY VALUE AND CHARACTERISTIC VALUE PROBLEMS 8+3
Shooting method, solution through a set of equations, derivative boundary conditions, Rayleigh-Ritz method, characteristic value problems, solution using Characteristic polynomial method, Jacobi method, Power method and Inverse power method.

UNIT III CALCULUS OF VARIATIONS 6+2
Variation and its properties – Euler’s equation – Functionals dependent on first and higher order derivatives - Functionals dependent on functions of several independent variables – Rayleigh Ritz method- Galerkin method.

UNIT IV PARTIAL DIFFERENTIAL EQUATIONS - NUMERICAL SOLUTION 7+3
Laplace’s equations, representations as a difference equation, Iterative methods for Laplace’s equations, Poisson equation, derivative boundary conditions, irregular and non-rectangular grids, Matrix patterns, Sparseness, ADI method, Applications to heat flow problems.

UNIT V PARABOLIC PARTIAL DIFFERENTIAL EQUATIONS 7+2
Explicit method, Crank-Nicholson method, derivative boundary condition, stability and convergence criteria, Parabolic equations in two or more dimensions, applications to heat flow problems.

UNIT VI HYPERBOLIC PARTIAL DIFFERENTIAL EQUATION 7+2
Solving wave equation by finite differences, stability of numerical method, method of characteristics, Wave equation in two space dimensions, computer programs.

Note: Assignments/Term papers using MATLAB / C / C++ to solve design problems.

REFERENCES:

L: 45, T: 15, Total: 60

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BoS Chairman
AIM:
This programme intends to develop a new breed of Post Graduate Engineers required for the tasks of Design and Development.

OBJECTIVES:
• To give students greater breadth and depth of technical knowledge in the areas of CAD/CAM
• To synthesize and apply the concepts learnt
• To provide experience in team-based engineering design projects
• The emphasis is on mathematical modeling and the application of quantitative techniques associated with design, manufacturing, optimization, probability and statistics to the design and operation of the systems.

UNIT I INTRODUCTION TO COMPUTER APPLICATIONS IN NEW PRODUCT DESIGN

UNIT II COMPUTERS IN DESIGN
Solid modeling of Mechanical components – associative features – Sheet metal components, nesting and development – plastic parts with draft and shrinkage allowance – Reverse engineering of components – assembly of parts – tolerance analysis – mass property calculations

UNIT III COMPUTERS IN TOOLING DESIGN
Mould design – jigs and fixtures design – check for interferences – mechanism design and analysis – Rapid tooling

UNIT IV COMPUTERS IN DESIGN PRODUCTIVITY
Customizing various software by using visual basic, pro/program, script, LISP etc to write applications like design of shafts, gears etc.,

UNIT V MANAGING PRODUCT DESIGN DATA
Version control – library creation – catalog making – standardization for design – collaborative design among peer groups – Design optimization for geometry - Design check, approval and validation.

REFERENCES:

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[Signature]
BoS Chairman
AIM:
To develop the theoretical basis and to derive the theories of the mechanical vibrations with sound mathematical principles and to enable students to systematically solve engineering problems regardless of difficulty.

OBJECTIVES:
- To learn analytical, experimental, and numerical treatment of single and multi DOF vibration systems. Free and forced vibrations of Mechanical systems with lumped inertia, springs, and dampers are the primary emphasis.

UNIT I  FUNDAMENTALS OF VIBRATION  8+3

UNIT II  TWO DEGREE FREEDOM SYSTEM  8+3

UNIT III  MULTI-DEGREE FREEDOM SYSTEM  12+3

UNIT IV  VIBRATION OF CONTINUOUS SYSTEMS  8+3

UNIT V  EXPERIMENTAL METHODS IN VIBRATION ANALYSIS  9+3

REFERENCES:

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L: 45, T: 15, Total: 60
AIM:
To study the application of computers in manufacturing section and also to study the components of industrial robotics and expert systems.

OBJECTIVES:
- To introduce the numerical control machine and automation, concept of Industrial robotics,
- To learn the concepts of GI, FMS, AGV's, AS / RS systems, various planning systems and process monitoring, Control systems concepts.
- To learn the basics about robotics and robot manipulation in space, the controlling of Robots and devices system, Sensor technology, Robot programming and expert system.

UNIT I
INTRODUCTION AND DESIGN FEATURES OF CNC MACHINES
Working principles of typical CNC lathes, turning centre, machining centre, CNC grinders, CNC gear cutting machines, wire cut EDM. Selection of CNC machine tools, structure, drive kinematics, gear box, main drive, selection of timing belts and pulleys, spindle bearings arrangement and installation. Recirculating ball screws, linear motion guide ways, tool magazines, ATC, APC, chip conveyors tool turrets, pneumatic and hydraulic control system, Open loop and closed loop systems, microprocessor based CNC systems, description of hardware and software interpolation systems, spindle encoder

UNIT II
PART PROGRAMMING OF A CNC LATHE
Process planning, tooling, preset and qualified tools, typical tools for turning and machining centres. Axes definition, machine and workpiece datum, turret datum, absolute and incremental programming, tape codes, ISO and EIA codes, G and M functions, tool offset information, soft jaws, tool nose radius compensation, long turning cycle, facing cycle, constant cutting velocity, threading cycle, peak drilling cycle, part programming examples.

UNIT III
MANUAL PART PROGRAMMING OF A MACHINING CENTRE
Co-ordinate systems, cutter diameter compensation, fixed cycles, drilling cycle, tapping cycle, boring cycle, fineboring, back boring cycle, area clearance programs, macro, parametric programming, part programming examples. CAD/CAM based NC programming, features of CAM packages.

UNIT IV
FUNDAMENTAL CONCEPT OF ROBOTICS AND ROBOT DRIVES

UNIT V
TRANSFORMATS AND KINEMATICS
Homogeneous co-ordinates, co-ordinate reference frames, homogeneous transformations for the manipulator, the forward and inverse problem of manipulator kinematics, motion generation, manipulator dynamics, robot programming.

REFERENCES
5. Programming instruction manuals of CNC lathes and machining centres, 2001

L: 45, T: 0, Total: 45

BoS Chairman
AIM:
To highlight the basic concepts and procedures for Mathematical Modeling and analysis of manufacturing systems

OBJECTIVES:
- To know the fundamentals of automation in material handling
- To understand the types and principles of manufacturing systems
- To learn the basic concepts and components of FMS
- To apply key management interfaces and activities
- To use the various optimized production techniques

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

UNIT II  MATERIAL FLOW SYSTEMS
Assembly lines—Reliable serial systems, approaches to line balancing, sequencing mixed models. Transfer lines and general serial systems-paced lines without buffers, unpaced lines. Shop scheduling with many products. Flexible manufacturing systems—system components, planning and control. Group technology, assigning machines to groups, assigning parts to machines. Facility layout—Quadratic assignments problem approach, graphic theoretic approach.

UNIT III  SUPPORTING COMPONENTS
Machine setup and operation sequencing-integrated assignment and sequencing. Material handling systems—conveyor analysis, AGV systems. Warehousing-storage and retrieval systems, order picking.

UNIT IV  GENERIC MODELING APPROACHES
Analytical queuing models, a single workstation, open networks, closed networks. Empirical simulation models— even models, process models, simulation system, example manufacturing system.

UNIT V  SYNCHRONIZATION MANUFACTURING
Synchronization Vs Optimization, defining the structure, identifying the constraint, exploitation, buffer management.

UNIT VI  PETRI NETS
Basic definitions—dynamics of Petri nets, transformation methods, event graphs, modeling of manufacturing systems.

REFERENCES:

L: 45, T: 0, Total: 45
AIM:
To equip the students with today's CAM packages

OBJECTIVES:
- To familiarize in part programming and tool path generation algorithms
- To understand the simulation concepts in CAM packages
- To provide students an extensive and intensive training in commercial CAM software


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Total : 45
AIM:
To study the basic principles and applications of the Finite Element Analysis in product development

OBJECTIVES:
- To introduce Engineering Analysis tool FEA, its application in Linear static Analysis and 2D problems
- To study Finite Element modeling and simulation Techniques
- To use FEA in structural vibration and thermal Analysis
- To study and use Finite Element Software (ANSYS)

UNIT I  INTRODUCTION & ONE-DIMENSIONAL PROBLEMS  10

UNIT II  TWO-DIMENSIONAL PROBLEMS  10

UNIT III  ISOPARAMETRIC ELEMENTS  8

UNIT IV  STRUCTURAL DYNAMICS APPLICATIONS  9

UNIT V  NON-LINEAR PROBLEMS & ERROR ESTIMATES  8

REFERENCES:

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BOS Chairman
AIM:
To explore the world of Micro electro mechanical devices and systems ("MEMS").

OBJECTIVES:
- To study about Micro electromechanical devices such as pressure sensors, accelerometers,
- To know about a broad range of disciplines, from micro fabrication to mechanics.

UNIT I  INTRODUCTION
Overview-Microsystems and microelectronics - Working principle of Microsystems -micro actuation techniques-microsensors-types-microactuators-types-micropump-micromotors-micro-valves-
microgippers-scaling laws-scaling in geometry-scaling in rigid body dynamics- scaling in electrostatic
forces-scaling in electricity-scaling in fluid mechanics-scaling in heat transfer.

UNIT II  MATERIALS AND FABRICATION PROCESS
Substrates and wafer-single crystal silicon wafer formation-ideal substrates-mechanical properties-
silicon compounds - SiO2, SiC, Si3N4 and polycrystalline silicon - Silicon piezoresistors - Gallium
aresenside, Quartz-piezoelectric crystals-polymers for MEMS -conductive polymers – Photolithography
- Ion implantation - Diffusion – Oxidation –CVD - Physical vapor deposition - Deposition by epitaxy -
etching process

UNIT III  MICROMECHANICS
Introduction-static bending of thin plates-circular plates with edge fixed - rectangular plate with all edges
fixed and square plate with all edges fixed – Mechanical vibration-resonant vibration- micro
accelerometers-design theory and damping coefficients- thermo mechanics-thermal stresses-fracture
mechanics-stress intensity factors, fracture toughness and interfacial fracture mechanics.

UNIT IV  MICRO SYSTEM MANUFACTURING
Clean room technology-Bulk Micro manufacturing- surface micro machining –LIGA-SLIGA-Micro
system packaging-materials-die level-device level-system level-system level-packaging techniques-die preparation-
surface bonding-wire bonding-sealing

UNIT V  MICRO SYSTEM DESIGN
Design considerations-process design-mask layout design- mechanical design-applications of micro
system in -automotive industry-bio medical –aero space- telecommunications.

REFERENCES:
2. Julian W.Gardner,Vijay K.Varadan,Osama O.Awadel Karim,Microsensors MEMS and Smart
   Devices, John Wiby & sons Ltd., 2001

L: 45, T: 0, Total: 45

BoS Chairman
AIM:
To study the various tools and approaches available for product design and development.

OBJECTIVES:
- To give a clear insight about various aspects of product design and development
- To develop a procedural approach for the product design and development

UNIT I INTRODUCTION

UNIT II PRODUCT PLANNING
Product Planning Process- Identifying Opportunities- Evaluating and Prioritizing Projects- Allocating Resources and Timing- Pre-Project Planning-Reflect on the Results and the Process-Identifying Customer Needs- Raw Data from Customers- Interpreting Raw Data in Terms of Customer Needs-Organizing the Needs into a Hierarchy-Establishing the Relative Importance of the Needs-Reflecting on the Results and the Process

UNIT III PRODUCT SPECIFICATIONS
Specifications - Specifications Established - Establishing Target Specifications-Setting the Final Specifications-Concept Generation-The Activity of Concept Generation-Clarify the Problem- Search Externally-Search Internally-Explore Systematically- Reflect on the Results and the Process.

UNIT IV CONCEPT SELECTION
Concept Selection- Overview of Methodology-Concept Screening-Concept Testing-Define the Purpose of the Concept Test- Choose a Survey Population- Choose a Survey Format- Communicate the Concept- Measure Customer Response-Interpret the Results- Reflect on the Results and the Process

UNIT V PRODUCT ARCHITECTURE
Product Architecture-Implications of the Architecture-Establishing the Architecture-Delayed Differentiation-Platform Planning-Related System-Level Design Issues

L: 45, T: 0, Total: 45

REFERENCES:

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B&O Chairman
AIM:
To study how a design can be made suitable for various manufacturing and assembly process requirements.

OBJECTIVES:
- To study the various factors influencing the manufacturability of components and the use of tolerances in manufacturing.
- To apply this study to various forging, casting, welding and machining processes
- To study about the various assembly methods and processes and design for assembly guidelines

UNIT I  INTRODUCTION
General design principles for manufacturability - strength and mechanical factors, mechanisms selection, evaluation method, Process capability - Feature tolerances Geometric tolerances - Assembly limits -Datum features - Tolerance stacks.

UNIT II  FACTORS INFLUENCING FORM DESIGN
Influence of materials on form design - form design of grey iron, malleable iron, steel and aluminium castings - form design of welded members, forgings.

UNIT III  COMPONENT DESIGN - MACHINING CONSIDERATION

UNIT IV  COMPONENT DESIGN - CASTING CONSIDERATION
Redesign of castings based on Parting line considerations - Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

UNIT V  DESIGN FOR THE ENVIRONMENT

REFERENCES:
3 Boothroyd, G, Heartz and Nike, Product Design for Manufacture, Marcel Dekker, 1994
4 Dickson, John, R, and Corroda Poly, Engineering Design and Design for Manufacture and Structural Approach, Field Stone Publisher, USA, 1995

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BoS Chairman
AIM:
To learn, formulate and solve design problems using state of the art commercial CAD/CAE packages.

OBJECTIVES:
- To equip the students with fundamental theories and technologies in geometric modeling algorithms, curves and surfaces, meshing algorithms,
- To provide students an extensive and intensive practice of a leading commercial CAD/CAE software with ample in-depth projects

UNIT I CAD (COMPUTER AIDED DRAFTING)
Modeling and Assembly of mechanical components using parametric and feature based packages. Introduction to CAD software, Part – Assembly –Drafting model of mechanical machine components like –Flange coupling, Universal coupling, Screw jack etc.

View: Orthographic view, Isometric view, Sectional view, Exploded view.

GD&T: Standard, Part list, Bill of Material, Machining symbols, Tolerance – Fits and Geometric.

UNIT II CAE (COMPUTER AIDED ENGINEERING)

Total: 45

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