Biju Patnaik University of Technology, Orissa
Rourkela

Syllabus
of
M.Tech
in
CAD/CAM

From 2009 -2010 Academic Session
M.Tech in CAD/CAM

SYLLABUS

First Semester
CMPC 101: Computer graphics
CMPC 102: Computer Applications in Design
CMPC 103: Data communication in CAD/CAM

Elective – I
CMPE 101: Tribology
CMPE 102: Finite element Analysis
CMPE 103: Management Information System
CMPE 104: Robotics

Elective – II
CMPE 105: Advanced Mechanism Design
CMPE 106: Computational Fluid Dynamics
CMPE 107: Industrial Safety Management
CMPE 108: Computer Integrated Design

CMPR101: CAD laboratory
CMPT101: Pre- Thesis Work & Seminar.
Second Semester

CMPC201: Computer Numerical Control Part programming
CMPC202: Advanced Strength of Materials
CMPC203: Computer Integrated Manufacturing

Elective – I

CMPE201: Mechantronics and Manufacturing Systems
CMPE202: Manufacturing Systems and simulation
CMPE203: Metrology and Non-destructive testing
CMPE204: Design for Manufacture

Elective – II

CMPE205: Manufacturing Information System
CMPE206: Design of Material Handling equipment
CMPE207: Performance modeling and analysis of manufacturing systems
CMPE208: Computer Aided Process Planning

CMPR201: CAM laboratory
CMCV201: Seminar - II
CMCV202: Comprehensive Viva Voce - II
1. INTRODUCTION
Definition and scope of CAD/CAM. Introduction to Design process and role of computer in design process. Hardware and software in CAD/CAM application.

2. GEOMETRICAL MODELING CURVES AND SURFACES
Representation, wire frame models, Intrinsic and parametric representation, analytic and paramedic curve and surface, Manipulations of curve and surface.

3. GEOMETRIC SOLID MODELING
Solid models Fundamentals of solid modeling. Half-spaces, Boundary representation (B-rep), Constructive solid geometry (CSG), sweep representation, analytic solid modeling, solid manipulations.

4. CAD/CAM DATA EXCHANGE FORMATES

5. INTRODUCTION TO DESIGN AND ENGINEERING APPLICATION.

6. INTRODUCTION TO REVERSE ENGINEERING TOOLS

Total number of periods: 45

Recommended books:
1. Ibrahim Zeid, CAD/CAM, Tata Mc Graw hill, New Delhi.
2. J. Rooney and P. Steadman, Principals of computer aided design, pitman/open university, London.
COMPUTER APPLICATIONS IN DESIGN  

1. INTRODUCTION TO COMPUTER GRAPHICS FUNDAMENTALS  
Output primitives (points, lines, curves etc.), 2-D transformation (Translation, scaling, rotators) windowing, view ports clipping transformation.

2. INTRODUCTION TO CAD SOFTWARE  
Writing interactive programs to solve design problems and production of drawings, using any languages like Auto LISP/C/FORTRAN etc., creation of surfaces, solids etc., using solid modeling pack (prismatic and revolved parts).

3. VISUAL REALISM  
Hidden - Line - Surface - solid removal algorithms shading - coloring. Introduction to parametric and variational geometry based on softwares and their principles creation of prismatic and lofted parts using these packages.

4. ASSEMBLY OF PARTS  
Assembly of parts, tolerance analysis mass property calculations, mechanism simulation.

5. SOLID MODELING  
Solid modelling - Rapid prototyping - Data exchange - Documentation - Customizing - solid modelling system.

Total No of periods: 45

References:

DATA COMMUNICATION IN CAD/CAM

1. DIGITAL COMPUTERS & MICRO PROCESSORS

2. OPERATING SYSTEM & ENVIRONMENTS
Types - functions - UNIX & WINDOWS NT - Architecture - Graphical User Interfaces. Compilers - Analysis of the Source program - the phases of a compiler - cousins of the compiler, the grouping of phases - compiler construction tools.

3. COMMUNICATION MODEL
Data communication and networking - protocols and architecture - data transmission concepts and terminology - guided transmission media - wireless transmission - data encoding - asynchronous and synchronous communication - base band interface standards RS232C, RS449 interface.

4. COMPUTER NETWORKS
Network structure - network architecture - the OSI reference model services - network standardization - example- Managing remote systems in network - network file systems - networking in manufacturing.

5. INTERNET
Internet services - Protocols - intranet information services - mail based service - system and network requirements - internet tools - usenet - e.mail - IRC - www - FTP - Telnet.

Total No of periods: 45

References:
## TRIBOLOGY

### 1. SURFACES, FRICTION AND WEAR


8

### 2. LUBRICATION THEORY

Lubricants and their physical properties lubricants standards - Lubrication Regimes Hydrodynamic lubrication - Reynolds Equation, Thermal, inertia and turbulent effects - Elasto hydrodynamic and plasto hydrodynamic and magneto hydrodynamic lubrication - Hydrostatic lubrication - Gas lubrication.

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### 3. DESIGN OF FLUID FILM BEARINGS

Design and performance analysis of thrust and journal bearings - Full, partial, fixed and pivoted journal bearings design - Lubricant flow and delivery - power loss, Heat and temperature rotating loads and dynamic loads in journal bearings - special bearings - Hydrostatic Bearing design.

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### 4. ROLLING ELEMENT BEARINGS


10

### 5. TRIBO MEASUREMENT IN INSTUMENTATION


7

**Total No of periods:** 45

### References:


   2. http://www.me.psu.edu/research/tribology.htm
FINITE ELEMENT ANALYSIS

1. 1D FINITE ELEMENT ANALYSIS
   Historical Background - Weighted Residual Methods - Basic Concepts of FEM - Variational Formulation of B.V.P - Ritz Method - Finite Element Modeling - Element Equations - Linear and Quadratic Shape functions - Bar, Beam Elements - Applications to Heat Transfer.

2. FINITE ELEMENT ANALYSIS OF 2D PROBLEMS

3. ISO PARAMETRIC FORMULATION

4. SOLUTION TO PLANE ELASTICITY PROBLEMS
   Introduction to Theory of Elasticity - Plane Stress - Plane Strain and Axisymmetric Formulation - Principle of virtual work - Element matrices using energy approach.

5. SPECIAL TOPICS

Total No of periods: 45

Text Books:

Web References:
2. http://www.mech.port.ac.uk/sdalby/mbm/CTFRProg.htm

2. INFORMATION SYSTEM TAXONOMIES: Transaction processing system, management information systems. Decision support system, Executive information systems. Artificial intelligence, Expert Systems and Office automation system.

3. SYSTEM ANALYSIS AND DESIGN: Information system planning, introduction challenges, strategic issues, selecting systems, project management issues. Methodology and implication of system analysis and design, SDLC, prototyping. End user development, off-the self software, out sourcing and application software.

4. TOOLS FOR INFORMATION SYSTEM DEVELOPMENT: Structural tools for analysis and design, tools to represent system data and process, tools for structured programming, tools to convert programs specified into code.

5. DATA BASE DESIGN AND MANAGEMENT: Components of DBMS, database models, Principle of DBMS.


7. VLINKER SERVER COMPUTING: Developing, Client server, organizational implication of c/s computing. Information system security and control.

8. ERP: Introduction, concepts, application advantages and disadvantages

Recommended books:
1. Uma G Gupta, Management information systems- a managerial perspective, Galgotia publishers, New Delhi.
2. Edward Yourdon, structured analysis, prentice hall of India, New Delhi.
4. Steve Alter, Management information system Benjamin Cummins, new york.

Total number of periods: 45
ROBOTICS


2. ROBOT IN WORK PLACE: Need for interfacing, part feeding, magazines, and Orienting devices. Special fixtures conveyor belts, Overhead transport, Work cell organization in robotic environment, Work cell design and control.

3. REPRESENTATION OF A ROBOT: Fundamental and graphical representation of Robots, Arm structures in use, structure to end effectors, Degrees of freedom of a rigid body, degrees of a robot, Degree of freedom and mobility.

4. ROBOT TECHNOLOGY: Robot anatomy and units, work volume, Element and type of drive and control systems, precision of movement, Actuators, power transmission systems, Manipulator kinematics and path control, configuration of robot controller.

5. TYPES OF GRIPPERS: Mechanical grippers, consideration in gripper selection and design.


7. METHOD OF ROBOT PROGRAMMING: Robot programming languages, introduction to intelligent Robots.

8. ROBOT APPLICATIONS IN INDUSTRIES: Material handling and processing, metal cutting processing, welding, spray coatings, inspection, Assembly and Hazardous operating conditions, safety in robot, social and labor issues in robotics. Material handling using AGVs automated storages system using mobile robots, Issues in implementation of robotics in industry.

Recommended books:
11. Bernard Hodges, Industrial Robotics, Jaic publishing house, Bombay

Total number of periods: 45
1. **INTRODUCTION**  
Review of fundamentals of kinematics--Mobility analysis --Formation of one D.O.F. multiloop kinematics chains, Network formula - Gross motion concepts.

2. **KINEMATIC ANALYSIS**  
Position analysis -Vectorloop equations for four bar, slider crank, inverted slider crank - Geared five bar and six bar linkages. Analytical method for velocity and acceleration analysis - Four bar linkage jerk analysis - Plane complex mechanism

3. **PATH CURVATURE THEORY**  
Fixed and Moving centrodes, inflection points and inflection circle. Euler Savary equation, Graphical constructions - Cubic of stationary curvature.

4. **SYNTHESIS OF MECHANISMS**  

5. **DYNAMIC OF MECHANISMS**  
Static force analysis with friction - Inertia force analysis - combined static and inertia force analysis.shaking force, Kinetostactic analysis. Introduction to force and moment balancing of linkages.

6. **SPATIAL MECHANISM AND ROBOTICS**  
Kinematic analysis of spatial RSSR mechanism - Denavit - Hartenberg parameters. Forward and inverse Kinematics of robotic manipulators

**Total No of periods: 45**

**References:**


**Web References:**

1. [http://www.machinedesign.com](http://www.machinedesign.com)
1. **GOVERNING DIFFERENTIAL EQUATION AND FINITE DIFFERENCE METHOD**

Classification, Initial and Boundary conditions, Initial and Boundary value problems. Finite difference method, Central, Forward, Backward difference, Uniform and non-uniform Grids, Numerical Errors, Grid Independence Test.

2. **CONDUCTION HEAT TRANSFER**

Steady one-dimensional conduction, Two and Three dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems.

3. **INCOMPRESSIBLE FLUID FLOW**


4. **CONVECTION HEAT TRANSFER AND FEM**

Steady One-Dimensional and Two-Dimensional Convection - Diffusion, Unsteady one-dimensional convection - Diffusion, Unsteady two-dimensional convection - Diffusion - Introduction to finite element method - Solution of steady heat conduction by FEM - Incompressible flow - Simulation by FEM.

5. **TURBULENCE MODELS**

Algebraic Models - One equation model, K-I Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

**Total No of periods:** 45

**References:**

1. SAFETY MANAGEMENT  8

2. OPERATIONAL SAFETY  10

3. SAFETY MEASURES  8
Layout design and material handling - Use of electricity - Management of toxic gases and chemicals - Industrial fires and prevention - Road safety - highway and urban safety - Safety of sewage disposal and cleaning - Control of environmental pollution - Managing emergencies in Industries - planning, security and risk assessments, on-site and off-site. Control of major industrial hazards.

4. ACCIDENT PREVENTION  9
Human side of safety - personal protective equipment - Causes and cost of accidents. Accident prevention programmes - Specific hazard control strategies - HAZOP - Training and development of employees - First Aid - Fire fighting devices - Accident reporting, investigation.

5. SAFETY, HEALTH, WELFARE & LAWS  10

Total No of periods:  45

Text Books:

   1. Occupational Safety Manual BHEL.
   2. Industrial safety and the law by P.M.C. Nair Publisher's, Trivandrum.
COMPUTER INTEGRATED DESIGN (3 – 1 – 0: 4)

1. INTRODUCTION
Phases of design - Standardization and interchangeability of machine elements - Tolerances for process and function - Individual and group tolerances - Selection of fits for different design situations - Design for assembly and modular constructions - Concepts of integration.

2. SHAFTING
Analysis and design of shafts for different applications - detailed design - preparation of production drawings - Integrated design of shaft, bearing and casing - Design for rigidity.

3. GEAR AND GEAR BOXES
Principles of gear tooth action - Gear correction - Gear tooth failure modes - Stresses and loads - Component design of spur, helical, bevel and worm gears - Design for sub assembly - Integrated design of speed reducers and multispeed gear boxes - application of software packages.

4. CLUTCHES
Integrated design of automobile clutches and over running clutches.

5. BRAKES
Dynamic and thermal aspects of vehicle braking - Integrated design of brakes for machine tools, automobiles and mechanical handling equipments.

References:

Web References:
http://wwwAGMA.org/

CAD LABORATORY (0 – 0 – 3 : 3)

The following experiments are to be conducted using appropriate software

1. Use of computer in the design process.
2. Wire-frame modeling of objects.
3. Solid modeling
4. Hidden line removal and shading
5. Rendering
6. Geometry and mass property calculations.
COMPUTER NUMERICAL CONTROL PART PROGRAMMING

(3 – 1 – 0: 4)

1. INTRODUCTION:
Basic concepts in manufacturing systems, fundamentals of numerical control advantages of NC systems, Classification of NC systems, point to point and countering systems, incremental and absolute systems, open loop and close loop systems, encoder, punched tape.

2. FEATURES OF NC MACHINE TOOLS:
Fundamental of machining, design consideration of NC Machine tools, methods of improving machine accuracy, tool deflection and chatter, lead screw, thermal deformations, increasing productivity with NC machines, machining centers.

3. NC PART PROGRAMMING:
Introduction, NC coordinate system, manual part programming, coe and concepts types to tape formats, Tool length and radius compensation, point to point and contour programming examples, canned cycles, Subroutine, MACROS simple problems of drilling, turning, and two-dimensional milling.

4. COMPUTER AIDED PART PROGRAMMING:
Advantages of computer aided programming, post processor, APT programming, Geometric statements, motion statements, additional AAPT statements, simple problems of APT programming.

5. CNC, DNC, AND ADAPTIVE CONTROL:
Introduction, problems with conventional NC, principles of operation of CNC, features of CNC, advantages of CNC, direct numerical control, types and functions of DNC, advantages of DNC, Adaptive control machining systems, types, benefits of Adaptive control systems.

Total number of periods: 45

Reference books
4. CAD/CAM – M.P.Groover and E.W.Zimmers (PHI)
5. Automation, production systems and CIM – M.P.Groover (P.H.I)
1. **ELASTICITY**

2. **SHEAR CENTRE**
Location of shear centre for various sections - shear flows.

3. **UNSYMMETRICAL BENDING**
Stresses and deflections in beams subjected to unsymmetrical loading-kern of a section.

4. **CURVED FLEXIBLE MEMBERS**
Circumference and radial stresses-deflections-curved beam with restrained ends-closed ring subjected to concentrated load and uniform load-chain links and crane hooks.

5. **STRESSES IN FLAT PLATES**
Stresses in circular and rectangular plates due to various types of loading and end conditions buckling of plates.

6. **TORSION OF NON-CIRCULAR SECTIONS**

7. **STRESSES DUE TO ROTARY SECTIONS**
Radial and tangential stresses in solid disc and ring of uniform thickness and varying thickness allowable speeds.

8. **CONTACT STRESSES**
Methods of computing contact stress-deflection of bodies in point and line contact applications.

**Total No of periods:** 45

**References:**

COMPUTER INTEGRATED MANUFACTURING

(3 – 1 – 0 : 4)

1. INTRODUCTION: Types of production system and their automation. CAD/CAM integration. Concept of FMS and CIMS.
2. ELEMENTS OF A GENERAL CIM SYSTEM: Type of the CIM systems. CAD?CAM link for CIMS> Manufacturing data base in a systems, equipment and their functions. Integration of robot in CIMS, Automatic storage and Retrieval system (AS/RS). Carousel, palletization and fixtures in process interfacing of storage with manufacture.
4. COMPUTER AIDED PRODUCTION PLANNING AND CONTROL: Inventory control and MRP, Computer aided cost estimation. Computer aided shop floor control, process monitoring , Computer aided inspection and quality control, SQC, SPC.
6. CIM DATABASE AND DATA BASE MANAGEMENT SYSTEM: Types, Management Information system, Manufacturing data preparation. Shop floor data collection systems, shop-floor control, sensors used ,tool management system automatic identification systems ,Barcode system.
7. CIMS CONFIGURATION: DNC based factory management and control, integrated CAD/CAM System and shared data base, Factories of the future. Impact of implementing CIMS on society. Introduction to rapid prototyping and rapid tooling Introduction to the concept of concurrent engineering.

Total number of periods: 45

Recommended books:
8. Dr. Surender Kumar and Dr. A. K. Jha, CAD/CAM, Dhanpat Rai and Sons, New Delhi.
# MECHATRONICS IN MANUFACTURING

(3 – 1 – 0 : 4)

## 1. INTRODUCTION

## 2. SENSORS AND TRANSDUCERS
Introduction - Performance Terminology - Displacement, Position and Proximity - Velocity and Motion - Fluid pressure - Temperature sensors - Light sensors - Selection of sensors - Signal processing - Servo systems.

## 3. MICROPROCESSORS IN MECHATRONICS

## 4. PROGRAMMABLE LOGIC CONTROLLERS
Introduction - Basic structure - Input / Output processing - Programming - Mnemonics - Timers, Internal relays and counters - Data handling - Analog input / output - Selection of PLC.

## 5. DESIGN AND MECHATRONICS
Designing - Possible design solutions - Case studies of Mechatronics systems.

Total No of periods: 45

## Text Books:


**Web Reference:** www.cs.indiana.edu.
MANUFACTURING SYSTEMS AND SIMULATION

(3 – 1 – 0 : 4)

1. COMPUTER MODELING AND SIMULATION SYSTEMS

2. RANDOM NUMBER GENERATION
Techniques for generating random numbers - midsquare method - the mid product method - constant multiplier technique - additive congruential method - linear congruential method - tests for random numbers - the Kolmogorov - Smirnov test - the Chi-Square test.

3. RANDOM VARIABLE GENERATION

4. DISTRIBUTION AND EVALUATION OF EXPERIMENTS

5. DISCRETE EVENT SIMULATION
Concepts in discrete-event simulation, manual simulation using event scheduling, single channel queue, two server queue, simulation of inventory problem. Programming for discrete event systems in GPSS - Case studies

Total No of periods: 45

Text Books:

1. MEASURING MACHINES

2. STATISTICAL QUALITY CONTROL
Data presentation - Statistical measures and tools - Process capability - Confidence and tolerance limits - Control charts for variables and for fraction defectives - Theory of probability - Sampling - ABC standard - Realibility and life testing.

3. LIQUID PENETRANT AND MAGNETIC PARTICLE TESTS

4. 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.

5. ULTRASONIC AND ACOUSTIC EMISSION TECHNIQUES
Production of ultrasonic waves - different types of waves - general characteristics of waves - pulse echo method - A, B, C scans - Principles of acoustic emission techniques - Advantages and limitations - Instrumentation - applications.

References:

Web References:
1. www.metrologytooling.com
2. www.sisndt.com
3. www.iuk'tu-harburg.de
DESIGN FOR MANUFACTURE

1. 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.

2. FACTORS INFLUENCING FORM DESIGN

Working principle, Material, Manufacture, Design - Possible solutions - Materials choice - Influence of materials on from design - from design of welded members, forgings and castings.

3. COMPONENT DESIGN-MACHINING CONSIDERATION


4. COMPONENT DESIGN - CASTING CONSIDERATIONS

Redesign of castings based on parting line considerations - Minimising core requirements, machined holes, redesign of cast members to obviate cores.

5. REDESIGN FOR MANUFACTURE AND CASE STUDIES

Identification of uneconomical design - Modifying the design - group technology - Computer Applications for DFMA

Text Books:

References:

Total No of periods: 45
MANUFACTURING INFORMATION SYSTEMS

(3 – 1 – 0 : 4)

1. INTRODUCTION  5
The evolution of order policies, from MRP to MRP II, the role of Production organization, Operations control.

2. DATABASE  7
Terminologies - Entities and attributes - Data models, schema and subschema - Data Independence - ER Diagram - Trends in database.

3. DESIGNING DATABASE  13
Hierarchical model - Network approach - Relational Data model - concepts, principles, keys, relational operations
- functional dependence - Normalisation, types - Query languages.

4. MANUFACTURING CONSIDERATION  10
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.

5. INFORMATION SYSTEM FOR MANUFACTURING  10
Parts oriented production information system - concepts and structure - computerised production scheduling, on-line production control systems, Computer based production management system, computerised manufacturing information system - case study.

Total No of periods:  45

References:

Web Reference:  www.ist.psu.edu
DESIGN OF MATERIAL HANDLING EQUIPMENT

(3 – 1 – 0 : 4)

(USE OF APPROVED DATA BOOK IS PERMITTED)

1. MATERIALS HANDLING EQUIPMENT 4
   Types, selection and applications

2. DESIGN OF HOISTS 15

3. DRIVES OF HOISTING GEAR 6
   Hand and power drives - Travelling gear - Rail traveling mechanism - cantilever and monorail cranes - slewing, jib and luffing gear - cogwheel drive - selecting the motor ratings.

4. CONVEYORS 10
   Types - description - design and applications of Belt conveyors, apron conveyors and escalators Pneumatic conveyors, Screw conveyors and vibratory conveyors.

5. ELEVATORS 10
   Bucket elevators: design - loading and bucket arrangements - Cage elevators - shaftway, guides, counter weights, hoisting machine, safety devices - Design of form lift trucks.

Text Books:

References:
PERFORMANCE MODELING AND ANALYSIS OF MANUFACTURING SYSTEM

(3 – 1 – 0 : 4)

1. MANUFACTURING SYSTEMS & CONTROL

2. MANUFACTURING PROCESSES

3. QUEUING MODELS
   Notation for queues - Examples of queues in manufacturing systems - Performance measures - Little's result - Steady state analysis of M/M/m queue, queues with general distributions and queues with breakdowns - Analysis of a flexible machine center.

4. QUEUING NETWORKS
   Examples of QN models in manufacturing - Little's law in queuing networks - Tandem queue - An open queuing network with feedback - An open central server model for FMS - Closed transfer line - Closed server model - Garden Newell networks

5. PETRI NETS

Total No of periods: 45

References:
# COMPUTER AIDED PROCESS PLANNING

(3 – 1 – 0 : 4)

## 1. INTRODUCTION
The Place of Process Planning in the Manufacturing cycle - Process Planning and Production Planning - Process Planning and Concurrent Engineering, CAPP, Group Technology.

## 2. PART DESIGN REPRESENTATION
Design Drafting - Dimensioning - Conventional tolerancing - Geometric tolerancing - CAD - input / output devices - topology - Geometric transformation - Perspective transformation - Data structure - Geometric modelling for process planning - GT coding - The optiz system - The MCLASS system.

## 3. PROCESS ENGINEERING AND PROCESS PLANNING
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.

## 4. 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.

## 5. AN INTERGARTED PROCESS PLANNING SYSTEMS

Total No of periods: 45

### References:

### Web References:
1. [http://claymore.engineer.gusu.edu/jackh/eod/automate/capp/capp.htm](http://claymore.engineer.gusu.edu/jackh/eod/automate/capp/capp.htm)
CAM Laboratory

- Practical to be conducted covering various aspects of computer control in M/C tools and robotics including:
- Study of structure of NC system
- Introduction and use of NC codes
- NC part programming of various parts
- Too and zero pre setting
- Flexible tooling
- Different type of NC motions
- Study of various drives, counters. ADC and DAC Devices etc
- Visit to one facility where any of the above is in use and to prepare a report.