SYLLABI
and
SCHEME OF TEACHING

MASTER OF ENGINEERING
IN
MECHANICAL ENGINEERING
(MANUFACTURING TECHNOLOGY)

MODULAR & REGULAR PROGRAMME
(2016 – 2017)

MECHANICAL ENGINEERING DEPARTMENT
NATIONAL INSTITUTE OF TECHNICAL TEACHERS TRAINING & RESEARCH
CHANDIGARH
September 2015
Instructions to Paper Setter

1. The examiner shall set eight questions, out of which the candidate is required to attempt any five questions. The Question-paper should be fairly distributed over the whole course of study and not concentrated on any one or a few portions only.

2. The Question-paper is to be set strictly according to the syllabus and not according to the last years question paper, which is being sent just as a sample only.

3. Special instructions if any, in regard to the paper should be followed.

4. For University examination the maximum marks are 50 and duration of examination is 3 hours.
### Table I

#### Study & Evaluation Scheme

**M.E. Mechanical Engineering (Manufacturing Technology) – Regular Programme**

#### First Semester

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**NOTE:**

1. Requirement for the award of ME Mechanical Engineering (Manufacturing Technology) degree is 75 credits with minimum CGPA of 6.0 and successful completion of thesis work.

2. Criteria for evaluating/grading of thesis of all ME courses from the session 2015-16 is as per the guidelines given below:

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M.E. MECHANICAL ENGINEERING (MANUFACTURING TECHNOLOGY) – MODULAR PROGRAMME

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Rationale: The Manufacturing Technologist must be endowed with the knowledge of different metal forming and joining processes and should have a thorough knowledge of the tooling and equipment required to carry those processes.

DETAILED CONTENTS

1. **Rolling of Metals**
   1.1 Rolling process and equipment
   1.2 Shape-Rolling Operations
   1.3 Production of Seamless Tubing and Pipe
   1.4 Continuous Casting and Rolling
   1.5 Calculation of blank size and no of passes
   1.6 Forces in rolling

2. **Forging of Metals**
   2.1 Forging process and equipment
   2.2 Metal flow in forging
   2.3 Forging die design principles
   2.4 Forging defects
   2.5 Economics of forging

3. **Extrusion and Drawing of Metals**
   3.1 Extrusion Process
   3.2 Hot and cold Extrusion
   3.3 Impact Extrusion
   3.4 Hydrostatic Extrusion
   3.5 Extrusion Defects
   3.6 Drawing Process
   3.7 Multistage drawing
   3.8 Deep Drawing
   3.9 Stretch forming
   3.10 Forces in drawing process
   3.11 Economics of drawing process

4. **Processing of Powder Metals and Ceramics**
   4.1 Production of Metal Powders
   4.2 Compaction of Metal Powders
   4.3 Sintering
   4.4 Secondary and Finishing Operations
   4.5 Design Considerations for Powder Metallurgy
   4.6 Process Capabilities
4.7 Economics of Powder Metallurgy
4.8 Shaping Ceramics
4.9 Design Considerations for Ceramics
4.10 RPT and Powder Processes—Selective Laser Sintering, Stereo Lithography, Subtractive Processes, additive Processes and Virtual Prototyping

5. Forming and Shaping Plastics and Composite Materials
   5.1 Plastics and Composite materials properties
   5.2 Cold Forming and Solid-Phase Forming
   5.3 Processing Elastomers
   5.4 Processing Reinforced Plastics
   5.5 Processing Metal-Matrix Composites
   5.6 Processing Ceramics-Matrix Composites
   5.7 Design Considerations and Economics of forming and shaping

6. Advanced Welding Practices
   6.1 Plasma Arc welding
   6.2 Submerged Arc Welding
   6.3 Welding of iron, steel and aluminum
   6.4 BIS codes on welding
   6.5 Inspection of welds and welded joints
   6.6 Welding defects

BOOKS:
MMT 6102: MATERIALS FOR MANUFACTURING

Maximum marks: 50
Time Allowed: 3 hours

Rationale: Manufacturing Technologist needs to have knowledge of various types of materials which are available along with the properties which may be chosen for the manufacture of any component / part / machine.

DETAILED CONTENTS

1. **Ferrous Metal Alloys**
   1.1 Review of crystal structure
   1.2 Solid solutions
   1.3 Iron-Carbon system
   1.4 Transformation processes related to phase changes
   1.5 TTT diagrams, isothermal and continuous cooling
   1.6 Cast Irons
   1.7 Heat Treatment Processes

2. **Nonferrous Metals and Alloys**
   2.1 Aluminum and Aluminum Alloys
   2.2 Copper and Copper Alloys
   2.3 Nickel and Nickel Alloys
   2.4 Super-alloys
   2.5 Titanium and Titanium Alloys
   2.6 Shape-Memory Alloys
   2.7 Amorphous Alloys

3. **Polymers**
   3.1 Structure of Polymers
   3.2 Thermoplastics
   3.3 Thermosetting Plastics
   3.4 Additives in Plastics
   3.5 General Properties and Applications of Thermoplastics
   3.6 General Properties and Applications of Thermosetting Plastics
   3.7 Biodegradable Plastics
   3.8 Elastomers (Rubbers)

4. **Ceramics, Graphite, and Diamond**
   4.1 Structure of Ceramics
   4.2 General Properties and Applications of Ceramics
   4.3 Graphite
   4.4 Diamond

5. **Composite Materials**
   5.1 Structure of Reinforced Plastics
   5.2 Properties of Reinforced Plastics
5.3 Applications of Reinforced Plastics
5.4 Metal-Matrix Composites
5.5 Ceramic-Matrix Composites

6. Non-Destructive Testing of Materials
6.1 X-Radiography
6.2 Ultrasonic testing
6.3 Magnetic particle testing
6.4 Eddy-current testing

BOOKS:
Rationale: Due to automation, there is a need to computerize the entire gamut of production activities both direct and indirect on the shop floor. The latest production management techniques of this subject will definitely help the manufacturing technologist to understand all the aspects of production planning and control.

DETAILED CONTENTS

1. Production Planning and Control
   1.1 Traditional PPC and its problems
   1.2 Symptoms of poor PPC system
   1.3 Operating priorities and principles
   1.4 Computer-integrated production management system, its need and requirement
   1.5 Use of computers in planning activities
   1.6 Cost planning and control

2. Forecasting
   2.1 Characteristics of a good forecasting system.
   2.2 Various models and their selection: Qualitative and Quantitative
   2.3 Benefits of forecasting

3. Aggregate Planning
   3.1 Performance measures: CPR and PPR
   3.2 Qualitative and quantitative methods

4. Master Production Scheduling
   4.1 Types of scheduling and need for re-scheduling
   4.2 Cut and Fit method

5. Capacity Planning
   5.1 Need for capacity planning
   5.2 Strategies for modifying capacity
   5.3 Capacity planning modeling: Short term and long term

   6.1 Importance of Inventory and inventory management
   6.2 Inventory management systems
   6.3 Material Requirement Planning (MRP)
   6.4 Working and benefits of different types of inventory system
   6.5 Performance measures
   6.6 Lot sizing methods
   6.7 Difference between MRP and MRP-II

7. Just In Time
   7.1 Introduction and its comparison with MRP
7.2 Pull and push system
7.3 Kanban-Types, benefits and calculation

8. **Shop Floor Control and Computer Process Monitoring**
   8.1 Functions of SFC
   8.2 SFC system
   8.3 Operation scheduling and techniques of operation scheduling
   8.4 Factory Data Collection system
   8.5 Computer Process Monitoring

9. **Supply Chain Management**
   9.1 Introduction and model of SCM
   9.2 Benefits and Performance measures in SCM.

10. **Enterprise Resource Planning**
    10.1 Main features
    10.2 Generic Model
    10.3 Selection of ERP system
    10.4 Problems in ERP implementation.

**BOOKS:**
MMT 6106: ADVANCED MANUFACTURING METHODS

Maximum marks: 50
Time Allowed: 3 hours

Rationale: The knowledge of this subject is required for precision machining of hard and tough materials. With the advent of new materials Manufacturing Technologist is facing many challenges to cut materials. This subject will equip him to solve such challenging situations.

DETAILED CONTENTS

1. Introduction to New Technology
   1.1 Need for New Technology
   1.2 Classification of New Technology
   1.3 Historical Background of New Technological Processes
   1.4 Definitions and Applications of Various Processes
   1.5 Comparative Analysis of Various New Technological Processes.

2. Mechanical Processes
   2.1 Abrasive Jet Machining
      2.1.1 Fundamental Principles
      2.1.2 Application Possibilities
      2.1.3 Process Parameters.
      2.1.4 Schematic Layout of Machine Tool
   2.2 Ultrasonic Machining
      2.2.1 Range and Application Possibilities of Ultra-sonic Machining
      2.2.2 Fundamental Principles
      2.2.3 Process Parameters
      2.2.4 Slurry and Selection of Abrasive
      2.2.5 Tool Design
      2.2.6 Tool Feeding Mechanism
      2.2.7 Transducers
      2.2.8 Analysis for Metal Removal Rate
      2.2.9 Design of Horn (Velocity Transformer)
      2.2.10 Analysis of Process Parameters

3. Chemical Machining
   3.1 Fundamental principles
   3.2 Process Parameters
   3.3 Classification and Selection of Material
   3.4 Selection of etchants

4. Electro-Chemical Processes
   4.1 Electro-Chemical Machining
      4.1.1 ECM Process
      4.1.2 Fundamental Principles of ECM
4.1.3 Classification of ECM Processes
4.1.4 Determination and evaluation of Metal Removal Rate
4.1.5 Electro-Chemistry of ECM
4.1.6 Dynamics of ECM Process
4.1.7 Hydrodynamics of ECM Process
4.1.8 Optimisation Analysis of ECM
4.1.9 Choice of Electrolyte

4.2 Electro-Chemical Grinding
4.2.1 Fundamental Principles
4.2.2 Electro-Chemistry of ECG
4.2.3 Basic Scheme of the Process
4.2.4 Classification of ECG
4.2.5 Process Parameters of ECG

5. Electrical Discharge Machining
5.1 Mechanism of Metal Removal
5.2 Basic EDM Circuitry and Operation
5.3 Analysis of Relaxation and E-L-C Type of Circuits
5.4 Evaluation of Metal Removal Rate
5.5 Evaluation of Machining Accuracy
5.6 Optimization Analysis of Metal Removal Rate in EDM Process
5.7 Selection of Tool Materials
5.8 Choice of Dielectric Fluid

6. Laser Beam Machining
6.1 Production of Photon Cascade in a Solid Optical Laser
6.2 Machining Applications of Laser

7. Electron Beam Machining
7.1 Background of Electron Beam Action
7.2 Dimensionless Analysis to Establish Correlation between EBM Parameters
7.3 Generation of Electron Beam
7.4 Advantages and Limitations

8. Plasma Arc Machining
8.1 Principles and Applications

9. Economics of Advanced Manufacturing Methods
9.1 Economic evaluation of advanced manufacturing process

BOOKS:
Rationale: The Manufacturing Technologist must be endowed with the knowledge of different metal cutting processes and should have a thorough knowledge of tooling required to carry those processes. He should be able to analyze these processes for efficient production work.

DETAILED CONTENTS

1 Introduction
   1.1. Machining Fundamentals
   1.2. Work-Tool Contact
   1.3. Machineable Surfaces
   1.4. Kinematics of Work-Tool Interaction
   1.5. Kinematic Elements in Metal Cutting Action

2 Cutting Tools
   2.1 Tool angle specification systems
   2.2 Geometry of Single-Point Turning Tools
   2.3 Interrelation between Different Systems of Rake Angle
   2.4 Determination of Normal Rake Angle
   2.5 Effective Rake in the Direction of Chip Flow
   2.6 Geometry of Twist Drills
   2.7 Geometry of Plain Milling Cutter

3 Mechanism of Chip Formation
   3.1 Chip Formation Process
   3.2 Classification of Chips
   3.3 Mechanics of Chip Curl
   3.4 Chip Formation Analysis
   3.5 Chip Formation Process in Drilling
   3.6 Chip Formation in Milling Process
   3.7 Mathematical Modeling of the Sources of Heat in affecting Rise Temperature
   3.8 Average Chip Tool Interface Temperature
   3.9 Distribution of Temperature at Chip Tool Interface
   3.10 Experimental Determination of Chip Tool Interface Temperatures

4 Mechanics of Metal Cutting
   4.1 Forces of Deformation at the Cutting Edge
   4.2 Forces in Turning
   4.3 Energy of cutting Process
   4.4 Effect of Nose Radius
   4.5 Force Analysis during Oblique Cutting
   4.6 Forces in Drilling Process
   4.7 Force System in Milling Process
5 Measurement of Cutting Forces
  5.1 Measurement of Forces
  5.2 Transducers for Force Measurement
  5.3 Design Requirements of Dynamometers
  5.4 Dynamics of Dynamometers
  5.5 Dynamometers for measuring Forces in Turning Process
  5.6 Drill Dynamometers
  5.7 Milling and Grinding Dynamometers

6 Failure of Cutting Tools
  6.1 Tool Failure
  6.2 Wear of Cutting Tools
  6.3 Effect of Mechanical Properties of Work Materials
  6.4 Effect of Tool Material
  6.5 Effect of Nose Radius
  6.6 Optimisation of Tool Geometry from Tool Life Consideration
  6.7 Selection of Cutting Conditions
  6.8 Experimental Evaluation of Taylor Exponent

7 Economics of Machining
  7.1 Economic Tool Life: Gilbert’s Model
  7.2 Optimisation for Maximum Production and maximum profit
  7.3 Generalised Analysis for Optimization of Cutting Conditions
  7.4 Constraint in optimization
  7.5 Selection of Optimum Cutting Parameters under Various Conditions

8 Future trends in machine tools
  8.1 Aims and trends of future development
  8.2 Design for improved static and dynamic performance
  8.3 Manufacturing systems concept
  8.4 Surface Integrity
  8.5 Ultra precision Machining
  8.6 Hard Turning

BOOKS:
MMT 6202: DESIGN FOR CONSUMER

Maximum marks: 50
Time Allowed: 3 hours

Rationale: For manufacturing any component / product the Manufacturing Technologist needs the knowledge of design, its approach, and detailed procedure according the needs of the consumer. By going through this subject he will be able to design any component very efficiently and economically.

DETAILED CONTENTS

1. Ergonomics
   1.1 Need for Ergonomics
   1.2 Areas of Study in Ergonomics
   1.3 Criteria in Assessing Ergonomic Problems and Solutions
   1.4 Human Characteristics Relevant to Ergonomics

2. Approaches and Models in Ergonomics
   2.1 How and Where Ergonomics is used?
   2.2 Models and Approaches in Ergonomics
   2.3 Systems Approach
   2.4 Various aspects of the System Design Process
   2.5 Workstation Analysis

3. The Design of Displays, Controls and Panels
   3.1 Design Criteria
   3.2 Types

4. Product Development
   4.1 Stages of Product Development
   4.2 The Feasibility Study
   4.3 Developing the Design and Selecting Materials and Processes
   4.4 Launching the Product
   4.5 Product Life Cycle

5. Elements of Engineering Design
   5.1 Factors Influencing Design
   5.2 Major Phases of Design
   5.3 Factor of Safety and Derating Factor
   5.4 Modeling and Simulation in Design

6. Functional requirements of Engineering Materials
   6.1 Selection of materials for static strength, stiffness, fatigue resistance and toughness

7. General Design Considerations
   7.1 Functional Requirements
   7.2 Effect on Environment
   7.3 Life
7.4 Reliability
7.5 Safety
7.6 Protection From Foreign Bodies
7.7 Standardization
7.8 Assembly
7.9 Maintenance
7.10 Costs
7.11 Quantity
7.12 Legal Matters
7.13 Patents
7.14 Appearance
7.15 Materials and Manufacturing Processes
7.16 Energy considerations

8. Decision Making in Design
8.1 Decision Matrix
8.2 Decision Trees
8.3 Optimization methods – Search techniques, Linear Programming and Geometric Programming

9. Effect of Material Properties on Design
9.1 Stress concentration
9.2 Designing for static strength, simple axial loading, torsional loading, bending and combined load
9.3 Designing with high strength low toughness materials
9.4 Designing against fatigue

10. Effect of Manufacturing Processes on Design
10.1 Design Considerations for Cast Components
10.2 Design Considerations for Moulded Plastic Components
10.3 Design Consideration for Forged Components
10.4 Design of Sheet Metal Parts
10.5 Design Involving Heat treatment
10.6 Designing for Corrosive Environments

BOOKS:
Rationale: Any manufacturing activity needs the design of tools hence all Manufacturing Technologists need knowledge of this subject for any component / product manufacture.

DETAILED CONTENTS

1. Cutting Tool Materials
   1.1 Introduction and desirable properties
   1.2 Carbon and Medium-Alloy Steels
   1.3 High-Speed Steels
   1.4 Cast-Cobalt Alloys
   1.5 Carbides
   1.6 Coated Tools
   1.7 Alumina-Based Ceramics
   1.8 Cubic Boron Nitride
   1.9 Silicon-Nitride Based Ceramics
   1.10 Diamond
   1.11 Reinforced Tool Materials
   1.12 Cutting-Tool Reconditioning

2. Design of Cutting Tools
   2.1 Basic Requirements
   2.2 Mechanics and Geometry of Chip Formation
   2.3 General Considerations for Metal Cutting
   2.4 Design of single point Cutting Tools
   2.5 Design of Milling Cutters
   2.6 Design of Drills and Drilling
   2.7 Design of Reamers
   2.8 Design of Taps
   2.9 Design of Inserts
   2.10 Determining Shank Size for Single-point Carbide Tools
   2.11 Determining the Insert Thickness for Carbide Tools
   2.12 Chip Breakers
   2.13 Design of form tools

3. Gages and Gage Design
   3.1 Limits fits and tolerances
   3.2 Geometrical tolerances-specification and measurement.
   3.3 Types of gages
   3.4 Gage design, gage tolerances
   3.5 Material for Gages
4. **Work Holding Devices**
   4.1 Basic requirements of work holding devices
   4.2 Location : Principles, methods and devices
   4.3 Clamping : Principles, methods and devices

5. **Drill Jigs**
   5.1 Definition and types of Drill Jigs
   5.2 Chip Formation in Drilling
   5.3 General Considerations in the Design of Drill Jigs
   5.4 Drill Bushings
   5.5 Drill Jigs, and Modern Manufacturing

6. **Design of Fixtures**
   6.1 Fixtures and Economics
   6.2 Types of Fixtures
   6.3 Milling Fixtures
   6.4 Boring Fixtures
   6.5 Broaching Fixtures
   6.6 Lathe Fixtures
   6.7 Grinding

7. **Tool Design for Numerically Controlled Machine Tools**
   7.1 Fixture Design for Numerically Controlled Machine Tools
   7.2 Cutting Tools for Numerical Control
   7.3 Tool-holding Methods for Numerical Control

**BOOKS:**

Rationale: Industrial automation is widely employed now a days, using pneumatic, hydraulic, electrical, electronics and computer systems. The modern engineering is incomplete without the knowledge of automation and control systems.

DETAILED CONTENTS

1. **Introduction**
   1.1. Concept and scope of automation
   1.2. Socio-economic consideration
   1.3. Low cost automation

2. **Fluid Power Control**
   2.1. Fluid power control elements and standard graphical symbols
   2.2. Construction and performance of fluid power generators
   2.3. Hydraulic and pneumatic cylinders- construction, design and mounting
   2.4. Hydraulic and pneumatic valves for pressure, flow and direction control
   2.5. Servo valves and simple servo systems with mechanical feedback
   2.6. Sequence operation and speed control using hydraulic/pneumatic actuator

3. **Electrical Actuation Systems**
   3.1. Mechanical switches
   3.2. Solid state switches
   3.3. AC and DC motors
   3.4. Stepper motor

4. **Transfer Devices and Feeders**
   4.1. Classification
   4.2. Construction details
   4.3. Application for job orienting and picking operations

5. **Control Theory**
   5.1. Mathematical modeling of physical systems
   5.2. Dynamic response of first and second order systems
   5.3. System transfer functions
   5.4. Frequency response
   5.5. PID controllers

6. **Data Acquisition**
   6.1. Sensors
   6.2. Operational amplifier
   6.3. Protection and filtering
   6.4. Digital signals
   6.5. Data acquisition systems
7. **Electronic Controllers**
   7.1. Digital logic
   7.2. Microprocessor structure
   7.3. Microcontrollers
   7.4. Programmable logic controllers

**BOOKS:**
Rationale: Understanding of integration of activities in an enterprise is very important to optimally utilize the resources. This subject will enable the students to understand the integration aspects so that these can be applied in the manufacturing situations.

DETAILED CONTENTS

1. Introduction
   1.1. Types of manufacturing systems and their characteristics
   1.2. Computer aided manufacturing (NC, CNC, DNC and adaptive control systems)
   1.3. Computer Network architectures and protocols

2. CNC Machines
   2.1. Constructional details
   2.2. Design features
   2.3. Safety devices
   2.4. Manual part programming
   2.5. Computer aided part programming using APT

   3.1. Planning function
   3.2. Retrieval and generative process planning systems
   3.3. Benefits of CAPP
   3.4. Machinability Data Systems
   3.5. Computer – Generated Time Standards

4. Group Technology and Cellular Manufacturing
   4.1. Parts classification and part coding – approaches and systems
   4.2. Benefits of group technology
   4.3. Cellular manufacturing-basics, layout considerations
   4.4. Cell formation approaches and evaluation of cell designs
   4.5. Planning and control in cellular manufacturing

5. Materials Handling and Storage
   5.1. Automated Material handling systems-AGVs, -types design features, guidance and control systems.
   5.2. Automated storage and retrieval system (ASRS)-components, design features and applications.

6. Flexible Manufacturing Systems
   6.1. FMS and its Components
   6.2. Layout considerations in FMS
   6.3. Benefits of FMS
7. **Industrial Robotics**
   7.1. Classification and basic motions
   7.2. Components, joints
   7.3. Robot Motion analysis-forward and backward kinematic transformations
   7.4. Programming of Robots
   7.5. Robot Applications
   7.6. Robot selection and economic justification

**BOOKS:**
MMT 6151: MANUFACTURING LAB – I

Note: The internal evaluation of the work done by the student will be based on a file documenting the practical work carried out during the course followed by a viva-voce examination.

PRACTICE TASKS

1. Study of rolling and forging processes.
2. Effect of draw force on wire diameter.
3. Study of any one RPT process in an industry.
4. Effect of heat treatment on properties of steels.
5. Microscopic examination and determination of chemical composition of ferrous and non-ferrous materials.
7. Non-Destructive Testing of materials for defects analysis and measurement purposes.
8. Metal Removal Rate and Tool wear studies in Spark Erosion Machining.
9. Case studies in special machining processes.
10. Study of parametric effects in gas welding.
Note: The internal evaluation of the work done by the student will be based on a file documenting the practical work carried out during the course followed by a viva-voce examination.

PRACTICE TASKS

1. Study of chip formation during turning, milling and drilling processes.
2. Study of different types of dynamometers and their usage.
4. Verification of tool-life equation.
5. Functioning of hydraulic actuators and manual/electrically operated valves.
7. Simulation of AND, OR, NOT, NAND, NOR, XOR logic using ladder diagrams.
8. Control of pneumatic and electrical actuators using PLC.
9. Gauge design for an industrial component.
10. Design of a drill jig.
MMT 6107: INDUSTRIAL INSTRUMENTATION

Maximum marks: 50
Time Allowed: 3 hours

Rationale: The Manufacturing Technologist must be endowed with the knowledge of instrumentation in order to monitor and control the manufacturing process. This subject will help him in the selection and use of measuring instruments.

DETAILED CONTENTS

1 Fundamental Concepts
   1.1 Applications of the Instrument Systems
   1.2 Functional Elements of a Measurement System
   1.3 Classification of Instruments
   1.4 Standards and Calibration

2 Static and Dynamic Characteristics of Instruments
   2.1 Static and dynamic characteristics
   2.2 Errors
   2.3 Static Performance Parameters
   2.4 Formulation of System Equations
   2.5 Dynamic Response
   2.6 Compensation

3 Elements of Instrumentation System
   3.1 Analog and Digital Transducers
   3.2 Amplifiers
   3.3 Compensators
   3.4 Differentiating and Integrating Elements
   3.5 Filters
   3.6 A-D and D-A Converters
   3.7 Data Transmission Elements
   3.8 Indicating and recording elements
   3.9 Data Acquisition Systems
   3.10 Data Display and Storage

4 Motion Measurements
   4.1 Relative Motion Measuring Devices
   4.2 Absolute Motion Measuring Devices
   4.3 Calibration of Motion Measuring Devices

5 Force Measurements
   5.1 Hydraulic and Pneumatic Load Cell
   5.2 Elastic Force Devices
   5.3 Separation of Force Components
   5.4 Calibration

6 Torque And Power Measurements
   6.1 Torque Measurement on Rotating Shaft
6.2 Shaft Power Measurement using Dynamometers

7 Pressure Measurements
7.1 High and Low Pressure (Vacuum) Measurement
7.2 Calibration

8 Temperature Measurements
8.1 Electrical and Non-electrical Methods
8.2 Radiation Methods (Pyrometry)

9 Flow Measurements
9.1 Primary or Quantity Meters
9.2 Secondary or Rate Meters

10 Condition Monitoring
10.1 Vibration and Noise Monitoring
10.2 Temperature Monitoring
10.3 Wear Behaviour Monitoring
10.4 Corrosion Monitoring
10.5 Performance Trend Monitoring
10.6 Selection of Condition Monitoring Techniques

BOOKS:
MMT 6108: COMPUTER PROGRAMMING AND APPLICATIONS

Maximum marks: 50
Time Allowed: 3 hours

Rationale: Since no field has remained untouched with the impact of Information Technology, therefore this subject is included to introduce the professionals to the applications of computers in Mechanical Engineering. This subject will enable students to understand the fundamentals and applications of computers, computer languages and system simulation etc.

DETAILED CONTENTS

1. Computer Programming
   1.1 Introduction to Computer Programming
   1.2 Algorithm and Pseudo-code
   1.3 Compilers and Interpreters
   1.4 Overview of High Level Programming Languages

2. Introduction to MATLAB
   2.1 MATLAB Environment
   2.2 Scalar and Vector Data types
   2.3 Matrix manipulation
   2.4 Saving and Retrieving Data using MAT-Files
   2.5 Cell Arrays and Structures
   2.6 Character Strings
   2.7 Relational and Logical Operations
   2.8 Plotting 2D and 3D graphs
   2.9 Applications – Solving linear systems of equations, Curve fitting and Interpolation

3. Programming using MATLAB
   3.1 Introduction – M-Files, User Input/output, Script-Files and Function-Files
   3.2 Control Flow – For Loops, While Loops, If-Else-End Constructs, Switch-Case Constructs, Try-Catch Blocks
   3.3 Functions – Function Construction Rules, Input and Output Arguments, Scope of Variables, Function Handles, Anonymous Functions, Nested Functions, Private Functions, Overloaded Functions
   3.4 Exchanging Data with MAT-Files
   3.5 Low level File I/O

4. Simulation
   4.1 Basic concepts of modeling and simulation
   4.2 Types of simulations - deterministic and stochastic simulations; continuous and discrete simulations and their applications
   4.3 Monte-Carlo Simulations – Design methodology of a simulation system
   4.4 Overview of simulation languages

5. Modeling and Simulation using MATLAB/Simulink
   5.1 Introduction to Graphical Programming
5.2 Simulink Basics
5.3 Creating Models using Blocks and Signals
5.4 Running Simulations and Analyzing Results
5.5 Modeling and Simulating Dynamic Systems
5.6 Modeling and Simulating Discrete Systems

PRACTICALS
1. Exercises on matrix creation and manipulation
2. Exercises on plotting and curve fitting
3. Solving Tool-Life equation using script files and function files
4. Exercises on search techniques and linear programming
5. Modeling and simulating Mass-Damper-Spring system
6. Modeling and simulating machine scheduling problems

BOOKS:
**MMT 6109: OPTIMIZATION TECHNIQUES**

Maximum marks: **50**

Time Allowed: **3 hours**

**Rationale:** Manufacturing Technologist needs to optimize the various manufacturing processes for the best utilization of men, materials and machines in any manufacturing activity.

**DETAILED CONTENTS**

1. **Numerical Techniques**
   1.1 Introduction to numerical techniques
   1.2 Numerical differentiation and numerical integration
   1.3 Eigen value problems
   1.4 Newton-Raphson’s method
   1.5 Computer based numerical analysis.

2. **Introduction to optimization**
   2.1 Introduction and Engineering applications of optimization
   2.2 Optimal Problem Formulation; Design – variables, Constraints, Objective function, Variable bounds.
   2.3 Integer Programming
   2.4 Geometric Programming

3. **Single-variable Optimization**
   3.1 Optimality Criteria
   3.2 Bracketing Methods – Exhaustive search and Bounding phase methods
   3.3 Region-Elimination Methods-Interval halving method; Fibonacci search method, golden section search method
   3.4 Point-Estimation Method : Successive quadratic estimation method
   3.5 Gradient-based Methods : Newton-Raphson method, Bisection method, Secant method, Cubic search method

4. **Multivariable Optimization**
   4.1 Optimality Criteria
   4.2 Unidirectional Search
   4.3 Direct Search Methods: Simplex, Hooke-Jeeves pattern search and Powell’s conjugate direction method.
   4.4 Gradient-based Methods: Cauchy’s (steepest descent) method, Newton’s method, conjugate gradient method, variable – metric method.

5. **Constrained Optimization**
   5.1 Kuhn-Tucker Conditions
   5.2 Transformation Methods: Penalty function method.
   5.3 Sensitivity Analysis
   5.4 Direct Search for Constrained Minimization : Variable elimination, Complex search and Random search methods.
5.5 Linearized Search Techniques: Frank-Wolfe method, Cutting plane method, Feasible Direction Method, Generalized Reduced Gradient Method, Gradient Projection Method.

BOOKS:
Rationale: Welding is a versatile fabrication process widely used in manufacturing industry. The knowledge of various types of welding techniques and their applications helps a manufacturing technologist select suitable type of welding technique for a given application.

DETAILED CONTENTS

1. **Introduction**
   1.1 Classification of Welding Processes
   1.2 General survey

2. **Fusion Welding Processes**
   2.1 Oxyfuel Gas Welding
   2.2 Arc –Welding Processes : Consumable Electrode
   2.3 Electrodes: Classification, Specification and selection of process parameters.
   2.4 Arc –Welding Processes : Non consumable Electrode
   2.5 Thermit Welding
   2.6 Electron – Beam Welding
   2.7 Laser-Beam Welding
   2.8 Cutting
   2.9 Welding Safety

3. **Solid – State Welding Processes**
   3.1 Cold welding
   3.2 Ultrasonic welding
   3.3 Friction welding
   3.4 Resistance welding
   3.5 Explosion welding
   3.6 Diffusion bonding (Welding)
   3.7 Diffusion bonding/superplastic forming

4. **Metallurgy of Welding**
   4.1 Welded Joint
   4.2 Weld Quality
   4.3 Weld ability
   4.4 Testing Welded Joints
   4.5 Weld Design and Process Selection

5. **Brazing, Soldering, Adhesive Bonding and Mechanical Fastening**
   5.1 Brazing
   5.2 Soldering
   5.3 Adhesive bonding
   5.4 Mechanical fastening
   5.5 Joining plastics
6. **Welding Practices**

6.1 Plasma arc welding
6.2 Submerged arc welding
6.3 Welding of materials like aluminium, copper, steel
6.4 BIS code on welding
6.5 Inspection of welds and welded joints
6.6 Welded defects & their causes

**BOOKS:**

MMT 7102: ARTIFICIAL INTELLIGENCE IN MANUFACTURING

Maximum marks: 50
Time Allowed: 3 hours

Rationale: Introduction to the concepts and tools of artificial intelligence and its applications in manufacturing are vital for the students of manufacturing technology, as this technique has been applied in various areas of manufacturing.

DETAILED CONTENTS

1. Introduction to Artificial Intelligence and Expert Systems
   1.1 Application areas of Artificial Intelligence
   1.2 Development of AI and Expert systems

2. Artificial Intelligence Programming Languages
   2.1 LISP
      2.1.1 Syntax and Numeric Functions
      2.1.2 List Manipulation Functions
      2.1.3 Functions and Predicates
      2.1.4 Conditionals and Iteration
      2.1.5 Property Lists and Arrays
   2.2 Introduction to MATLAB Toolboxes for AI Applications
      2.2.1 Fuzzy Logic Toolbox
      2.2.2 Neural Networks Toolbox
      2.2.3 Genetic Algorithm Toolbox
      2.2.4 Computer Vision Toolbox

3. Knowledge Representation
   3.1 Computational Logic
   3.2 First Order Predicate Logic
   3.3 Resolution and Unification
   3.4 Knowledge representation methods
   3.5 Knowledge Representation
   3.6 Uncertain Knowledge and Probabilistic Reasoning

4. Search Methods and Matching Techniques
   4.1 Blind Search Techniques
   4.2 Informed Search Techniques
   4.3 Structures used in Matching
   4.4 Measures for Matching
   4.5 Fuzzy and RETE Matching Algorithms

5. Expert Systems
   5.1 Structure of expert systems
   5.2 Expert system development
   5.3 Knowledge acquisition
   5.4 Types of Expert systems shells and their comparative evaluation.
   5.5 Application of expert systems in manufacturing
6. **Machine Vision and Image Processing**  
   6.1 Machine vision fundamentals  
   6.2 Image Acquisition  
   6.3 Image Processing  
   6.4 Application in manufacturing  

7. **Soft Computing Techniques**  
   7.1 Introduction to fuzzy logic  
   7.2 Fuzzy logic based decision making  
   7.3 Artificial Neural network  
   7.4 Architecture of neural network system  
   7.5 Genetic Algorithm Basics  
   7.6 Common Tuning Options in GA  
   7.7 Applications of soft computing techniques in manufacturing  

**BOOKS:**  
Rationale: Throughout the life cycle of engineering products, computers have a prominent role. In the process of product design, this role is becoming increasingly important due to competitive pressures. Therefore, the knowledge of fundamentals and various hardware/software tools of CAD for manufacturing are indispensible for a manufacturing technologist.

DETAILED CONTENTS

1. Computer Aided Design
   1.1 Fundamentals
   1.2 Design processes and computer aided design
   1.3 Hardware and software in CAD
   1.4 Parametric and variational design

2. CAD Software
   2.1 Components of CAD software and their function
   2.2 Introduction and essential features of graphics package
   2.3 Configuration of graphics package
   2.4 Geometric transformations-2D and 3D

3. Geometric Modelling
   3.1 Curves-mathematical representation of analytical and synthetic curves
   3.2 Curve manipulation
   3.3 Surfaces and their representation
   3.4 Solids-representation techniques and manipulation of solids

4. CAD Database
   4.1 Need and features of CAD data base
   4.2 Data structures
   4.3 Data exchange and data exchange formats

5. Manufacturing Applications
   5.1 Finite Element analysis- introduction
   5.2 Rapid Prototyping
   5.3 Virtual Manufacturing

6. Features of some Software Packages
   6.1 Pro-Engineer
   6.2 CATIA or INVENTOR
   6.3 Steps for geometrical modeling and analysis of simple components.
BOOKS:
MMT 7104 : INDUSTRIAL PROJECT MANAGEMENT

Maximum marks: 50

Time Allowed: 3 hours

L P

Rationale: Project management is the application of knowledge, skills, tools and techniques to bring about the successful completion of specific engineering project goals and objectives. This course provides project management fundamentals and techniques with focus on Mechanical Engineering Industry.

DETAILED CONTENTS

1. Introduction to Industrial Projects
   1.1 Introduction
   1.2 Projects and Different types of Projects
   1.3 Requirement Specification
   1.4 Steps in project planning
   1.5 Management Control

2. Project Evaluation
   2.1 Evaluation / Assessment of projects
   2.2 Strategic Program Management
   2.3 Cost-benefit Analysis
   2.4 Cash flow forecasting

3. Project Approach
   3.1 Selection of an appropriate project technology
   3.2 Project Structuring

4. Activity Planning
   4.1 Objective of Planning
   4.2 Project Schedule
   4.3 Activities – Sequencing and Scheduling
   4.4 Time Estimation
   4.5 Critical Path and Activities

5. Risk Management
   5.1 Bottlenecks
   5.2 Identification

6. Resource Management
   6.1 Resources
   6.2 Nature of Resources
   6.3 Resource Requirement
   6.4 Allocation, Monitoring and Control
7. **Project Time Management**
   7.1 Time Representation: Gantt Chart and Network Diagram
   7.2 Network Techniques: CPM, MPM, PERT, GERT, VERT
   7.3 CPM: Activity Scheduling and Float Analysis

8. **Managing People and Organizing Teams**
   8.1 Associating human resource with job
   8.2 Decision Making
   8.3 Health and Safety

9. **Introduction to P.M Softwares**
   9.1 M.S Projects
   9.2 GANTT Project
   9.3 Some Case Studies

**BOOKS:**
MTE 6202: RESEARCH METHODOLOGY

Maximum marks: 50 L P
Time Allowed: 3 hours 4 --

Rationale: The subject of research methodology covers the concepts and applications of tools useful for conducting research in a scientific manner. Therefore this subject is relevant for the students at Masters’ level.

DETAILED CONTENTS

1. Introduction Research Methodology
   1.1 Definition of Research
   1.2 Need of Research
   1.3 Concept and steps of Research Methodology
   1.4 Uses of Research Methodology, Research Techniques

2. Reviewing Literature
   2.1 Need
   2.2 Sources – Primary and Secondary
   2.3 Purposes of Review
   2.4 Scope of Review
   2.5 Steps in conducting review

3. Identifying and defining research problem
   3.1 Locating, Analyzing stating and evaluating problem
   3.2 Generating different types of hypotheses
   3.3 Hypothesis evaluation

4. Method of Research
   4.1 Descriptive research design-survey
   4.2 Case study
   4.3 Content analysis
   4.4 Ex-post Facto Research
   4.5 Co-relational and Experimental Research

5. Sampling Techniques
   5.1 Concept of population and sample
   5.2 Sampling techniques
      5.2.1 Simple random sampling
      5.2.2 Stratified random sampling
      5.2.3 Systematic sampling
      5.2.4 Cluster sampling
   5.3 Quota sampling techniques
   5.4 Determining size of sample

6. Procedure of data collection
   6.1 Aspects of data collection
   6.2 Techniques of data Collection
7. **Statistical Methods of Analysis**
   7.1 Descriptive statistics
      7.1.1 Meaning
      7.1.2 Graphical representations
      7.1.3 Mean, range and standard deviation
   7.2 Characteristics and uses of normal curve.

8. **Inferential Statistics**
   8.1 T-test
   8.2 Chi-square tests
   8.3 Correlation (rank difference and product moment)
   8.4 ANOVA (one way)

9. **Procedure for writing a research proposal and report**
   9.1 Purpose, types and components of research proposal
   9.2 Audiences and types of research reports
   9.3 Format of Research report and journal

10. **Case Studies on software tools used for research work**

**BOOKS:**
Rationale: Project management is the discipline of planning, organizing, securing and managing resources to bring about the successful completion of specific engineering project goals and objectives. Thus the knowledge of this subject will prove to be very useful to engineers in the execution of projects.

DETAILED CONTENTS

1. Introduction to Project Management
   1.1 Introduction
   1.2 Importance of software project management
   1.3 Project and different types of project
   1.4 What is management?
   1.5 Problems with software projects
   1.6 Environmental Appraisal with Projects
   1.7 Requirement Specification
   1.8 Management Control
   1.9 Steps in project planning

2. Programme Management and Project Evaluation
   2.1 Programme Management
   2.2 Managing resources within programme
   2.3 Strategic programme management
   2.4 Aids to programme management
   2.5 Evaluation / Assessment of projects
   2.6 Cost-benefit Analysis
   2.7 Cash flow forecasting
   2.8 Cost-benefit evaluation techniques
   2.9 Risk evaluation

3. Project Approach and Software Effort Estimation
   3.1 Selection of an appropriate project technology
   3.2 Choice of process model
   3.3 Data Structure
   3.4 Delivery Model
   3.5 Basis for software estimation
   3.6 Problem with over and under estimates
   3.7 Estimation Techniques
   3.8 Expert judgment
   3.9 Albrecht Function Point Analysis
   3.10 Function points Mark II
   3.11 COSMIC Function point
   3.12 COCOMO Model
4. **Activity Planning**
   4.1 Objective of Planning
   4.2 Project Schedule
   4.3 Activities – Sequencing and Scheduling
   4.4 Development of Project Network
   4.5 Time Estimation
   4.6 Forward and backward Pass
   4.7 Critical Path and Activities

5. **Risk Management**
   5.1 Risk - Definition
   5.2 Risk categories
   5.3 Identification
   5.4 Assessment, planning and management
   5.5 PERT and CPM Models
   5.6 Monte Carlo Simulation

6. **Resource Allocation, Monitoring and Control**
   6.1 Resources
   6.2 Nature of Resources
   6.3 Resource Requirement
   6.4 Scheduling, Counting and Costing
   6.5 Monitoring Framework
   6.6 Cost Monitoring
   6.7 Earned Value Analysis
   6.8 Project targets
   6.9 Change Control Management

7. **Managing People and Organizing Teams**
   7.1 Management Spectrum
   7.2 Associating human resource with job
   7.3 Motivation
   7.4 Oldham- job Characteristics Model
   7.5 Decision Making
   7.6 Leadership
   7.7 Stress, Health and Safety

**BOOKS:**
Rationale: Business process reengineering encompasses techniques to help organizations fundamentally rethink how they do their work in order to improve customer service, cut operational costs, and become world-class competitors. The knowledge of business process reengineering will help engineers to redesign the way work is done to achieve organizational mission.

DETAILED CONTENTS

1. Introduction
   1.1 Definition of Business Process Reengineering
   1.2 Historical perspective
   1.3 Role of information Technology

2. Implementation of Business Process Reengineering
   2.1 Development of Process Objectives
   2.2 Identification of Processes to be reengineered
   2.3 Measurement of existing Processes
   2.4 Utilization of Information Technology
   2.5 Design and Evaluation of Process Prototypes

3. The Reengineering Structure
   3.1 The Business Process Reengineering Leader
   3.2 The Process Owner
   3.3 The Reengineering Teams
   3.4 Other Employees involved

4. Change Management as an Enabler of Business Process Reengineering
   4.1 Why Change Management?
   4.2 Nature of Change
   4.3 Process of Change
   4.4 Roles of Change
   4.5 Resistance to Change
   4.6 Commitment to Change
   4.7 Culture and Change
   4.8 Resilience and Change

5. Common Mistakes in Business Process Reengineering
   5.1 Reengineering too many Processes
   5.2 Inadequate Training of Process Owners and Team Members
   5.3 Improper Monitoring
   5.4 Wastage of Time
   5.5 Delay in Showing Results
   5.6 Discontinuance after Achievement
BOOKS:
Rationale: This course will provide students with an understanding of human development as a continual process, with an ongoing requirement of adapting and adjusting to the environment. The course will also assist the students in developing a practical understanding of the process of human development.

DETAILED CONTENTS

1. Introduction to Human Resource Development
   1.1 Evolution
   1.2 Mission and Purpose
   1.3 Components of HRD
   1.4 HRD problems and issues related to Indian Industry and technical education
   1.5 HRD in the context of new Industrial Policy

2. Staff Development, Professional Development and Career Development
   2.1 Stages of HRD
   2.2 Initial or Induction Training
   2.3 Training for job-related/professional development
   2.4 Training for horizontal and vertical mobility of employees

3. Concept of Training
   3.1 Assumptions for prevailing and alternative concept of training
   3.2 Action through training or action through force

4. Training Strategy
   4.1 Strategic issues
   4.2 Basic phases
   4.3 Modalities in training
   4.4 Formulating a coherent strategy

5. Training Methods
   5.1 Learning on the job - Training in the fields
   5.2 Simulating real life - role playing and games
   5.3 Incidents and cases - Individualized training
   5.4 Seminars and syndicates
   5.5 Lecture method

6. Developing Group and the Climate
   6.1 The Social process
   6.2 Indicators of group development
   6.3 Training climate

7. Evaluation of Training
   7.1 Issues for evaluations
   7.2 Role of the Training System with evaluators from other constituencies
8. **Systems Approach to HRD**

8.1 Definition and importance of needs assessment

8.2 Methods employed in needs assessment (Interviews, Questionnaire, Tests, Records and Reports Study, Job Analysis and Performance Reviews)

8.3 Strategies for HRD: on the job, off the job

8.4 Program Planning

8.5 Design, Implementation and Evaluation

**BOOKS:**

MTE 7103: TECHNOLOGY MANAGEMENT

Maximum marks: 50
Time Allowed: 3 hours

Rationale: Manufacturing Technologist needs to learn technology management principles for the integrated planning, design, optimization, operation and control of technological products, processes and services.

DETAILED CONTENTS

1. **Introduction to Technology Management**
   1.1 Technology management fundamentals

2. **Business strategy for new technologies**

3. **Technology forecasting**
   3.1 Techniques of Forecasting
   3.2 Technology Forecasting-Relevance
   3.3 Strategic alliance and Practicality and Technology transfer.

4. **Management of research, development and innovation**
   4.1 Technology mapping
   4.2 Comparison of types of R&D project and development approaches – radical platform and Incremental projects,
   4.3 Innovation process.

5. **Management of intellectual property rights**
   8.1 Strategic value of patents
   8.2 Trade secrets and licensing

6. **Managing scientists and technologists**
   6.1 Identification
   6.2 Recruitment
   6.3 Retention
   6.4 Team work and Result orientation

7. **Management roles and skills for new technology**

8. **Technology for managerial productivity and effectiveness**
   8.1 Just-in-Time

9. **Venture capital & technology development**

BOOKS: