

# **COURSE STRUCTURE & SYLLABUS OF BACHELOR OF TECHNOLOGY (B.TECH)**

*In*

**Mechanical Engineering**

**Course Structure**

**Third Year**

**Fifth Semester**

<b>Paper Code</b>	<b>Subject</b>
BTM1	Metal Cutting and Tool Design
BTM2	Control System
BTM3	Computer Graphics
BTM4	CNC Programming
BTM5	Operation Research

## **BTM1 : METAL CUTTING AND TOOL DESIGN**

### **1 METAL MACHINING**

Introduction

### **2 MECHANICS OF METAL CUTTING**

Chip formation. Shear Zone. Shear Plane angle: Different Theories. Friction in Metal Cutting. Chip Flow Velocity. Shear Strain.

### **3 MEASUREMENT OF CUTTING FORCES**

Dynamometer Requirements. Classification of Cutting Force Dynamometers. Mechanical Type Hydraulic and Pneumatic Type. Optical Type. Inductance Type. Piezoelectric Type. Strain, Gauge Dynamometers. Lathe Tool Dynamo-meter. Drill Dynamometer, Milling Dynamometer. Grinding Dynamometer.

### **4 HEAT IN METAL CUTTING**

Heat Sources in Metal Cutting. Temperature in Chip Formation. Temperature Distribution. Factors Effecting the Temperature-Work Material, Cutting Variables, Tool Geometry, Cutting Fluid.

### **5 FAILURE OF CUTTING TOOLS**

Tool Wear and Tool Life; Premature failure. Gradual Wear. Crater Wear. Flank Wear, Grooving Wear, Chip notching, Wear Mechanisms in Metal Cutting, Abrasive Wear, Diffusion Wear. Adhesion, Oxidation Wear. Tool Life, Taylor's Tool Life Equation. Woxen's Equation. Cutting Conditions for Limiting Tool Life Conditions. T-V-he Tool Life Plots. Cutting Rate- Tool Life Characteristics Curve.

### **6 TOOL WEAR MEASUREMENT**

Optical Methods; Flank Wear, Crater Wear Measurement. Radioactive Methods. Electron Probe Micro Analyser-EPMA. Energy\_ Dispersive X-ray Analysis-EDXA. Augur Electron SpectroScopy -AES.

- 7 TOOL MATERIALS**  
Requirements of Tool Material. Classification. Tool Steels. H.S.S. Coated H.S.S. Powder Metallurgy H.S.S. Cast Cobalt Alloys-Stellite, Cemented Carbides; Tungsten Carbide Manufacture of Powder, Blending, Briquetting, Sintering, Hot Isostatic Pressing, Properties. Multi Carbide Tools; Properties. Coated Carbide tools; Coating Techniques; PVD Process, CVD Process. Performance of coated Tools. Oxicoated Tools. TiN coated Tools. ALON coated Tools.
- 8 CEMENTED TITANIUM CARBIDE TOOL**  
Properties, Microstructure Performance, Crater Wear Propagation. Diffusion Wear in CTC tools. Mechanisms of Wear in CTC tools. Ledge Formation, TiC coated CTC Tools. Microstructure. Performance.
- 9 CERAMIC CUTTING TOOLS**  
Manufacture; Powder Preparation, Sintering. Additives, Properties. Performance. SIALON tools. Cubic Boron Nitride (CBN) tools; Properties, Applications. Synthetic Diamond tools; Properties; Performance.
- 10 TOOL GEOMETRY**  
Tool Nomenclature. Basic Tool Angles, Effect of Basic Angles. Tool Nomenclature Systems; British System, American Standard Association System, German System, ISO System. Geometrical Relationship of True Rake Angle, Angle of Inclination.
- 11 CUTTING FLUIDS**  
Functions of Cutting Fluid, Lubrication in Metal Cutting; Cooling Properties of Cutting Fluids. Types of Cutting Fluids; Petroleum Based, Emulsified, Synthetic Type. Additives, Selection and Application of Cutting Fluids.
- 12 ECONOMICS OF MACHINING**  
Production Cost. Economic Tool Life. Optimum Cutting Speed for Maximum Production. Tool Life for Maximum Profit.
- 13 CUTTING TOOL DESIGN**  
General Considerations.
- 14 DESIGN OF SINGLE POINT TOOL**  
Tool Strength and Rigidity. Design of Form Tools. Types of Form Tools. Circular Form Tool. Profile Design; Geometrical Method. Analytical Method. Flat Form Tool Design. Grinding the Form Tool. Profile for a Tapered Surface. Tangential Type of Form Tool.
- 15 DESIGN OF DRILL**  
Twist Drill Construction. Drill Diameter. Flute Angle. Web Thickness and Chisel Edge. Land Width Margin. Shape of Flute Section. Flute Length, Shank. Geometry of the Cutting Edge, Rake Angle, Relief Angle, Angle of Inclination.
- 16 DESIGN OF MILLING CUTTER**  
Types of Milling Cutters, Profile Sharpened, Form Relieved Milling Cutters. Design of Profile Sharpened Milling Cutters. Design of Form Relieved Milling Cutters.
- 17 DESIGN OF BROACH**  
Design Elements of Broach. Number of Teeth, Tooth, Pitch and Chip space. Rear Pilot Length of Broach, Strength of Broach.
- 18 CUTTING TOOL MANUFACTURING**  
Single Point Tool Production. Twist Drill Production, Manufacture of Broach. Manufacture of Milling Cutter.
- 19 GEAR CUTTING TOOLS**  
Gear Form Cutting Tools. Gear Generation Cutting Tools. Design of a Gear Cutting Hob. Profile in the Normal Section. Diameter of the Hob. Hob Length. Relief Angle. Cam Relief. Pitch Cylinder Diameter. Gear Shaper Tools.
- 20 THREAD CUTTING TOOLS**  
Thread Cutting Dies. Thread Rolling Tools. Design of Thread Cutting Taps.
- 21 DESIGN OF REAMER**  
Reamer Design. Length. Flutes. Rake Angle and Relief Angle. Grinding of Reamer.

## **BTM2 : CONTROL SYSTEM**

- 1     **INTRODUCTION TO CONTROL SYSTEM**  
Classification Of Systems, Open-Loop Control System, Closed-Loop Control Systems, Elements Of Automatic Or Feedback Control System, Requirement Of Automatic Control Systems
- 2     **MATHEMATICAL MODELS OF CONTROL SYSTEM**  
Representation Of a Control System, Description Of Some Of Typical Physics System, Tachnogenators, Potentiometers, LVDT and Synchros, Synchros, Hydraulic Actuation
- 3     **BASIC PRINCIPLES OF FEEDBACK CONTROL**  
The Control Objectives, Feedback Control System Characteristics, Proportional Mode Of Feedback Control, Integral Mode Of Feedback Control, Derivative Mode Of Feedback Control
- 4     **TIME DOMAIN ANALYSIS AND FREQUENCY RESPONSE**  
Standard Test Signals, Static Accuracy, Computation Of Steady State Errors, Transient Response: First Order System, Transient Response: Second Order System, Transient Response Specification, Conclusion, Frequency Response, Frequency Domain Specifications, Magnitude And Phase Angle Characteristics Plot, Frequency Response Specification, Representation Sinusoidal Transfer Function
- 5     **CONCEPTS OF STABILITY AND THE ROUTH STABILITY CRITERION**  
Bounded-Input Bounded-Output Stability, Zero-Input Stability, The Routh Stability Criterion
- 6     **NYQUIST STABILITY CRITERION**  
Stability Margin, Phase Margin
- 7     **BODE PLOTS**
- 8     **ROOT LOCUS**  
The transfer function of a second order control system, General Rules

### **BTM3 : COMPUTER GRAPHICS**

1. **INTRODUCTION**  
Overview Of Computer Graphics, Representing Pictures, Preparing Pictures For Presentation, Presenting Previously Prepared Pictures
2. **GRAPHICS HARDWARE AND DISPLAY DEVICES**  
Storage Tube Graphics Displays, Calligraphic Refresh Graphics Displays, Raster Refresh Graphics Displays, Cathode Ray Tube Basics, Color Crt Raster Scan Basics, Video Basics, Interactive Devices
3. **GRAPHIC PRIMITIVES – DRAWING LINES & CURVES**  
Introduction, Scan-Converting A Point, Scan-Converting A Straight Line, Scan-Converting A Circle, Scan-Converting An Ellipse, Scan-Converting Arcs And Sectors , Scan-Converting A Rectangle, Boundary Block Transfer (Bitblt) Or Raster Operational Graphics , Side Effects Of Scan Conversion
4. **2D AND 3D TRANSFORMATIONS**  
2d Transformations, Homogeneous Coordinates And Matrix Representation Of 2d Transformations, Composition Of 2d Transformations, The Window-To-Viewport Transformation, Efficiency, Matrix Representation Of 3d Transformations
5. **SEGMENTS AND THEIR APPLICATIONS**  
Polygon Surfaces, Polygon Tables, Curved Lines And Surfaces, Quadric Surfaces, Superquadrics, Blobby Objects, Spline Representations, Cubic Spline Interpolation Methods, Bezier Curves And Surfaces, B-Spline Curves And Surfaces, Beta-Splines, Rational Splines, Conversion Between Spline Representations, Displaying Spline Curves And Surfaces, Sweep Representations
6. **GEOMETRIC MODELLING**  
Geometric Models, Hierarchy In Geometric Models, Interconnections, Characteristics Of Retained-Mode Graphics Packages, Defining And Displaying Structures

**7. BOUNDARY REPRESENTATIONS, CONSTRUCTIVE SOLID GEOMETRY AND SPATIAL DATA STRUCTURES**

Polyhedra And Euler's Formula, The Winged-Edge Representation, Boolean Set Operations, Spatial-Partitioning Representations, Constructive Solid Geometry, Comparison Of Representations, User Interfaces For Solid Modeling

**8. HIDDEN SURFACE AND LINE ELIMINATION**

Classification Of Visible-Surface Detection, Back-Face Detection, Depth-Buffer Method, A-Buffer Method, Scan-Line Method, Depth - Sorting Method, Bsp-Tree Method, Area-Subdivision Method, Octree Methods, Ray-Casting Method, Curved Surfaces, Wireframe Methods, Visibility-Detection Function

**9. RENDERING**

Light Sources, Basic Illumination Models, Displaying Light Intensities, Halftone Patterns And Dithering Techniques, Polygon-Rendering Method, Ray-Tracing Methods, Radiosity Lighting Model, Environment Mapping, Adding Surface Detail, Modeling Surface Detail Polygon

**10. VIDEO GAMES AND COMPUTER ANIMATION**

Conventional And Computer-Assisted Animation, Animation Languages, Methods Of Controlling Animation, Basic Rules Of Animation, Problems Peculiar To Animation

**BTM4 : CNC PROGRAMMING**

**1 LITERATURE SURVEY**

Chronological Development of CNC Machine, Machining Time , Non-machining Time , Loading and Unloading Time

**2 INTRODUCTION TO CNC MACHINE**

Definition, Classifications of Numerical Control System, Advantages of CNC Machine, Principle of Operation of CNC Machine , Open Loop CNC System , Closed Loop CNC System, Distance Measurement, Axis Arrangement of CNC Machines , Types of CNC Machines, Configuration Of CNC Machines, Parts Construction of CNC Machines ,Coordinate Systems, Grid System, Reference Points, Machine Origin, Part Origin, Program Origin, Coding System, CNC Syntax , Computer Word Address Format, End of Block Code , Accuracy and Repeatability of CNC Machine

**3 CONSTRUCTION FEATURES OF CNC MACHINES**

Constructional Features of CNC Machines, Structure , Slide Ways, Spindle Drive , Feed Drive, Position Measuring Devices, Selection of CNC Machine , Selection Guidelines , Choosing a Machining Center, Comparison Chart of Specification and Features of a Horizontal Spindle Machining Center, Typical Specifications for a Horizontal Spindle Machining Center, Typical Format for Comparison of CNC System.

**4 CNC MACHINE OPERATING SYSTEM**

FANUC Operating System , Flow Chart of Automatic Operation, Sinumerik/hinumerik Operating System, List of Operating Switches.

**5 PROGRAMMABLE LOGIC CONTROLLER (PLC) CHARACTERISTICS**

G-function (Preparatory Function), G-Codes , Cutter Compensation Function , Incremental Programming , Main Program ,Subprogram ,List of G-Function , List of M-function , Other Functions ,

**6 SETTING THE MACHINE**

Home Position , Coordinate System Preset, Tool Offset Consideration , Tool Length Offset , Tool

Offset Adjustment, Setting up Tools on the Lathe , Imaginary Tool Tip Method , CNC Turning Centre , Setting Work Coordinate System , Tool Offset , Tool data , Setting up Tools on the Machining Centre .

**7 CNC PROGRAMMING**

CNC Machining Centre, CNC Turning Centre , Automatically Programmed Tools (APT) Language , Motion Statements ,

**8 CNC METAL CUTTING TOOLS**

Characteristics of Tool Materials, Cutting Tool Materials , Cutting Tool Material Chart ,Calculation Formulae for Turning , Calculation formulae for Milling , ISO Designation of Tool, ISO Designation for Round Shank Tools, ISO Designation for Cartridges , Widax -gw Full Form, ISO Designation for Indexable inserts , Chart for Determining Spindle Speeds , Recommended Machining Parameters, Nomogram, For Power/Machining Parameters , Widalon/Widadur/Widia Grades for Machining, Grades for Machining .

**9 TROUBLE SHOOTING OF MACHINING PROCESSES**

Drilling, Tapping, Reaming, Spot Facing, Turning, Boring, Milling

**10 INTRODUCTION TO FMS, CIM SYSTEM AND ROBOTS**

Flexible Manufacturing System (FMS), Computer Integrated Manufacturing (CIM), Robots

**BTM5 : OPERATION RESEARCH**

**1. CLASSIFICATION OF O.R. MODELS**

Physical Models, Symbolic Models, Advantages Of A Model, Limitations Of The Model, Scope Of Operations Research In Management

**2. LINEAR PROGRAMMING FORMULATION & GRAPHICAL METHOD**

Introduction, Basic Requirements, Basic Assumptions, Advantages Of Linear Programming, Limitations Of Linear Programming, Application Areas Of Linear Programming, Formulation Of Linear Programming Models

**3. TRANSPORTATION**

Example, Agriculture, General Mathematical Formulation Of Linear Programming Problem, Definitions

**4. SOME SPECIAL CASES**

Multiple Optimal Solutions, Infeasible Solution, Contradictory Constraints, Unbounded Solution

**5. LINEAR PROGRAMMING**

The Simplex Method, Introduction, Standard Form Of Linear Programming Problem, Slack And Surplus Variables, Slack Variable

**6. STEPS OF THE SIMPLEX METHOD**

Steps of the Simplex Method (Maximization Case), Flow Chart of the Simplex Method, Simplex Method (Minimization Case), Steps of the Simplex Method (Minimization Case), Maximization Case (Constraints of Mixed Type), Resolution of Degeneracy

**7. LINEAR PROGRAMMING, DUALITY**

Introduction, Formulation Of Dual Problem, Interpreting Primal-Dual Optimal Solutions, Solving The Primal-Dual Problem, Dual Of A Primal With Mixed Constraints, Important Primal-Dual Results, Advantages Of Duality, The Dual Simplex Method

**8. TRANSPORTATION PROBLEM**

Methods For Finding Initial Solution, North-West Corner Method (NWCM), Least Cost Method (LCM), Vogel's Approximation Method (VAM), Stepping-Stone Method, The Dual of Transportation Problem, Alternative Optimal Solutions, Unbalanced Transportation Problems, Supply Exceeds Demand, Demand Exceeds Supply, Degeneracy in the Transportation Problem, Prohibited Routes, Profit Maximization in a Transportation Problem, Trans-shipment Problem, Time-Cost Trade-of in the Transportation problem

9. **HUNGARIAN METHOD OF ASSIGNMENT PROBLEM**  
Minimization Case, Variations Of The Assignment Problem, An Application--Airline Crew Assignment, Travelling Salesman Problem
10. **NETWORK MODELS : PERT & CPM**  
Objectives of network analysis, Application of network models, Advantages of network models, Project network, Difference between PERT and CPM, Activities, Events, Estimating Activity Times, Effect of Introducing a Dummy Activity in a Network, Probability Statements or Project Duration, Probability of completing the project on or before a specified time, PERT algorithm
11. **FLOAT OF AN ACTIVITY**  
Introduction, Optimization of Project Time and Cost in a PERT Network, Limitations of PERT/CPM
12. **QUEUING MODELS**  
Basic Components of the Queuing System, Input Source, Queue Discipline, Service Mechanism, Classification of Queuing Systems, Characteristics of Model I, II, III
13. **INVENTORY CONTROL MODELS**  
Principal Categories of Inventories and Their Functions, Structure of Inventory Management System, The Basic Deterministic Inventory models, Multiple Item Deterministic Models, Limitation set up by capital restriction, Aggregate resource limitations, Selective Inventory Control, Application of ABC analysis, Inventory Control Systems, Reorder level, Probabilistic Models
14. **SYSTEM TERMINOLOGY**  
System and Simulation models, Random Variable and Random Numbers, Monte-Carlo Simulation, Generation of Random Numbers, Simulation and Inventory Control, Simulation and Queuing System, Simulation and Capital Budgeting , Limitations of Simulation, Simulation Languages, Simulation Applications