

**UNIT - I****Chapter 1 : Mechanics of Metal Cutting 1-1 to 1-32**

Syllabus : Introduction to metal cutting, Elements of machining process, Geometry of single-point cutting tool, Orthogonal and Oblique cutting processes, Chip formation, Types of chips, Chip thickness ratio, Process parameters and their effect on machining, chip breakers, Merchant's Circle of forces analysis - forces and energy calculations, power consumed - MRR- Effect of Cutting variables on forces, Concepts of Machinability - Factors affecting machinability, Machinability Index, Tool Life, Tool life equation of Taylor, Tool wear and its types, Factors affecting on tool life.

1.1	Introduction.....	1-2
1.2	Classification of Machining Processes	1-2
1.3	Cutting Tool.....	1-8
1.4	Single Point Cutting Tool	1-9
1.4.1	Geometry of Single Point Cutting Tool.....	1-10
1.5	Mechanics of Shearing	1-11
1.5.1	Difference between Orthogonal and Oblique Cutting	1-12
1.6	Process Parameters and their Effect on Machining.....	1-12
1.7	Concept of Chip Formation in Metal Cutting ..	1-13
1.7.1	Types of Chips.....	1-13
1.7.2	Comparison between Continuous, Discontinues and Continuous Chips with Built up Edge.....	1-15
1.7.3	Chip Breakers.....	1-15
1.8	Shear Plane Angle (ϕ)	1-16
1.9	Chip Velocity	1-17

1.10	Shear Stress	1-18
1.11	Shear Strain and Shear Strain Rate	1-18
1.12	Cutting Forces in Oblique Cutting	1-19
1.13	Cutting Forces in Orthogonal Cutting	1-19
1.14	Power Requirement and Work Done in Metal Cutting	1-25
1.15	Introduction to Tool Dynamometer.....	1-26
1.16	Machinability	1-27
1.17	Tool Life and Taylor's Tool Life Equation	1-28
1.18	Tool Wear and types of Tool Wear	1-30
1.18.1	Types of Tool Wear	1-31
1.19	Cutting Fluids and their Types	1-31

UNIT - II**Chapter 2 : Gear and Thread Manufacturing****2-1 to 2-24**

Syllabus : Introduction, Materials of gears, Methods of gear manufacturing-casting, forging, forming etc., milling of gears (indexing methods and numerical), Helical gear cutting, Gear Shaping and Gear hobbing, Gear inspection.

Thread Manufacturing : Various methods of thread manufacturing, thread rolling, die threading & tapping, Thread milling, Thread grinding etc.

2.1	Gear Manufacturing.....	2-2
2.2	Materials of Gears	2-2
2.3	Types of Gear Manufacturing Methods	2-3
2.3.1	Gear Forming Methods.....	2-3
2.3.2	Gear Roughing Methods.....	2-4
2.4	Gear Milling	2-4



2.4.1	Advantages and Limitations of Gear Milling.....	2-5
2.5	Indexing.....	2-6
2.5.1	Methods of Indexing	2-7
2.6	Gear Hobbing.....	2-11
2.6.1	Types of Gear Hobbing Machine.....	2-12
2.6.2	Advantages and Limitations of Gear Hobbing.....	2-12
2.6.3	Difference between Gear Milling and Gear Hobbing.....	2-12
2.7	Helical Gear Cutting by Hobbing.....	2-13
2.8	Gear Shaping.....	2-13
2.8.1	Types of Gear Shaping	2-14
2.8.2	Advantages and Limitations of Gear Shaping.....	2-15
2.9	Gear Finishing Methods.....	2-15
2.10	Gear Inspection.....	2-16
2.11	Thread Manufacturing.....	2-18
2.12	Thread Rolling	2-18
2.12.1	Advantages and Disadvantages of Thread Rolling.....	2-19
2.13	Thread Machining	2-19
2.13.1	Thread Cutting on Lathe	2-19
2.13.2	Die Threading.....	2-20
2.13.3	Thread Tapping.....	2-20
2.13.4	Thread Milling.....	2-21
2.13.5	Difference between Thread Tapping and Milling	2-22
2.14	Thread Grinding.....	2-23

UNIT - III

Chapter 3 : Grinding and Surface Finishing 3-1 to 3-25

Syllabus : Types and Operations of grinding machines,
Grinding wheel : Shapes, Designation and selection, Abrasives & classification, Bond & bonding, Grit, Grade & Structure of wheels, Types of grinding wheels, mounting of grinding wheels, Glazing and loading of wheels, Dressing and truing of wheels, Balancing of wheels, Diamond wheels.
Super-finishing processes : Introduction to Honing, Lapping, Buffing and Burnishing. (Construction, working and controlling parameters).

3.1	Introduction to Grinding Machines	3-2
3.2	Types and Operations of Grinding Machines....	3-2
3.3	Shapes or Types of Grinding Wheels	3-11
3.4	Designation or Nomenclature of Grinding Wheel	3-12
3.5	Selection of Grinding Wheels.....	3-13
3.6	Procedure for Mounting of Grinding Wheels	3-15
3.7	Glazing and Loading of Wheels	3-15
3.8	Dressing and Truing of Grinding Wheels.....	3-16
3.9	Balancing of Grinding Wheels	3-17
3.9.1	Static Balancing (Outside the Machine)	3-17
3.9.2	Dynamic Balancing (Inside Machine)	3-18
3.10	Diamond Wheels for Grinding Ceramics.....	3-18
3.11	Machining Time Calculations for Cylindrical and Plunge grinding.....	3-19
3.12	Superfinishing Operations.....	3-20
3.12.1	Lapping Process.....	3-21
3.12.2	Honing Process.....	3-22



3.12.3	Difference between Lapping and Honing.....	3-23
3.12.4	Buffing.....	3-23
3.12.5	Burnishing	3-24

UNIT - IV

Chapter 4 : Jigs and Fixtures 4-1 to 4-47

Syllabus : Significance and purpose of jigs and fixtures and their functions in the manufacturing processes, Concept of degree of freedom, 3-2-1 principle of location. General guidelines to design jigs and fixtures, advantages of jigs and fixtures.

Jigs : Definition, Elements of jig with the types, Location guidelines, Principles of clamping, Principles of guiding, Channel jig, Template jig, Plate jig, Angle plate jig, Turn over jig, Box jig, Latch type jig.

Fixtures : Definition, Elements of fixtures, Location guidelines, Principles of clamping, Principles of setting element, turning fixture, welding fixture, Milling fixture, Assembly and Inspection fixtures.

4.1	Introduction.....	4-2
4.1.1	Significance and Purpose of Jigs and Fixtures.....	4-2
4.1.2	Difference between Jigs and Fixtures.....	4-3
4.2	Design Requirements of Jigs and Fixtures	4-4
4.3	Advantages and Disadvantages of Jigs and Fixtures	4-5
4.3.1	Advantages of Jigs and Fixtures	4-5
4.3.2	Disadvantages of jigs and Fixtures	4-5
4.4	Analysis for Operation Planning.....	4-5
4.4.1	Sequencing of Operations	4-6
4.5	Basic Construction of Jig and Fixture	4-8
4.6	Location and Locating Devices	4-8

4.6.1	Locating Principles.....	4-8
4.7	Locators.....	4-11
4.7.1	Locators that Control Workpiece on Flat Surfaces.....	4-12
4.7.2	Location of Cylindrical Surfaces.....	4-13
4.7.3	Conical Locators.....	4-13
4.7.4	Centralizers	4-13
4.7.5	Loading from an Internal Diameter	4-14
4.8	Clamping and Clamping Devices.....	4-15
4.8.1	Requirement of Clamping System.....	4-15
4.8.2	Position of Clamps	4-15
4.8.2.1	Clamping Force	4-16
4.9	Types of Clamps	4-16
4.9.1	Strap Clamps or Lever Type Clamps.....	4-16
4.9.2	Screw Clamp	4-17
4.9.3	Swing Clamp	4-18
4.9.4	Hook Clamp.....	4-18
4.9.5	Wedge Clamp	4-18
4.9.6	Quick Acting Clamps.....	4-18
4.10	Other Clamping Devices.....	4-20
4.10.1	Multiple Clamping Devices.....	4-20
4.10.2	Power Clamping Devices.....	4-21
4.11	Component Distortion Under Clamping and Cutting Forces	4-22
4.12	Introduction to Jigs.....	4-23
4.13	Selection of Location, Supporting and Clamping Faces / Points.....	4-23
4.13.1	Selection of Location Points and Supports	4-23



4.13.2	Selection of Clamping Points	4-24	4.18	Type of Milling Machines.....	4-34
4.14	Cutting Tools and Means of Guiding and Supporting jigs	4-24	4.18.1	Vertical Milling Machine	4-34
4.14.1	Drilling.....	4-24	4.18.2	Horizontal Milling Machine.....	4-34
4.14.2	Reaming.....	4-24	4.18.3	Type of Cutter Used	4-34
4.14.3	Tapping	4-24	4.18.4	Classification of Milling Based on Feed Direction.....	4-34
4.14.4	Chamfering	4-25	4.19	Selection of Location, Supporting and Clamping Faces / Points.....	4-35
4.14.5	Counter Boring	4-25	4.19.1	Requirements of Milling Fixture.....	4-35
4.14.6	Counter Sinking.....	4-25	4.20	Tool Setting Blocks and Tennon's	4-36
4.14.7	Reverse Counter Sinking	4-25	4.20.1	Tool Setting Block	4-36
4.15	Drill Bushes.....	4-25	4.20.2	Tennon's	4-36
4.15.1	Types of Drill Bushes	4-26	4.21	Type of Fixtures	4-36
4.15.2	Installation of Drilling Bushes.....	4-28	4.21.1	According to Structure	4-36
4.15.3	Commonly Used Drill Jigs.....	4-28	4.21.2	According to the Machine Used.....	4-38
4.15.3.1	Template Jig	4-29	4.22	Turning Fixture	4-38
4.15.3.2	Plate Jig.....	4-29	4.22.1	Chucks.....	4-39
4.15.3.3	Channel Jig	4-29	4.22.2	Face Plate	4-40
4.15.3.4	Diameter Jig.....	4-29	4.22.3	Collets	4-40
4.15.3.5	Solid Jig.....	4-29	4.22.4	Mandrels.....	4-41
4.15.3.6	Post Jig	4-30	4.23	Welding Fixture	4-43
4.15.3.7	Angular Post Jig.....	4-30	4.24	Introduction to Inspection Fixtures and Assembly Fixture	4-43
4.15.3.8	Turn Over Jig.....	4-30	4.24.1	Inspection Fixtures	4-43
4.15.3.9	Box Jig	4-30	4.24.2	Assembly Fixtures	4-44
4.15.3.10	Latch Type Jig.....	4-31	4.25	Modular Fixture	4-44
4.15.3.11	Sandwich Jig.....	4-31	4.25.1	Advantages of Modular Fixtures	4-44
4.15.3.12	Indexing Jig.....	4-31	4.26	Poka-yoke Concept in Jigs and Fixtures	4-45
4.16	Case Study on Design of Drill Jig	4-32			
4.17	Introduction to Milling Fixture.....	4-33			



4.27	Case Study on Design of Milling Fixture	4-46
------	---	------

UNIT - V

Chapter 5 : Process Planning 5-1 to 5-29

Syllabus : Introduction, Methods of Process Planning, Drawing Interpretation, material evaluation, Steps in process selection, production equipment and tooling selection, Process parameters calculations for various production processes, selection of jig's and fixtures, selection of quality assurance methods, documents for process planning, economics of process planning, case studies.

5.1	Introduction.....	5-2
5.2	Manufacturing System	5-2
5.3	Manufacturing Engineering	5-2
5.4	Process Planning.....	5-4
5.5	Process Planning Activities.....	5-4
5.6	Process Planning Documentation	5-6
5.7	Methods of Process Planning	5-8
5.7.1	Manual Process Planning	5-8
5.7.2	Computer Aided Process Planning (CAPP).....	5-9
5.8	Material Selection Process	5-10
5.8.1	Material Selection Methods.....	5-11
5.9	Process Selection	5-11
5.9.1	Process and Operations Sequencing.....	5-11
5.9.2	Guidelines for Process Selection.....	5-12
5.9.3	Case Studies	5-17
5.10	Production Equipment and Tooling Selection.....	5-19
5.10.1	Equipment Selection Methods	5-19
5.10.2	Factors in Tooling Selection.....	5-20
5.10.3	Operating Requirement for Tool Selection.....	5-20

5.10.4	Tooling Selection Methods	5-20
5.11	Process Parameters.....	5-20
5.11.1	Factors Affecting Speed, Feed and Depth of Cut...5-21	
5.12	Work-Holding Devices.....	5-23
5.13	Selection of Quality Assurance Methods	5-23
5.13.1	Quality	5-23
5.13.2	Quality Assurance	5-24
5.14	Inspections.....	5-24
5.14.1	Planning of Inspection.....	5-25
5.14.2	Types of Inspection.....	5-25
5.15	Economics of Process Planning.....	5-27
5.15.1	Cost Categories.....	5-28

UNIT - VI

Chapter 6 : CNC Programming 6-1 to 6-31

Syllabus : CNC Programming-CNC part programming adaptable to suitable controller. Steps in developing CNC part program. CNC part programming for Lathe Machine – Threading & Grooving cycle (Canned cycle). CNC part programming for Milling Machine - Linear & circular interpolation, milling cutter, tool length compensation & cutter radius compensation. Pocketing, contouring & drilling, subroutine and Do loop using canned cycle.

6.1	Introduction	6-2
6.2	Computer Numerical Control (CNC) Machines.....	6-2
6.2.1	Advantages of CNC Machine	6-2
6.2.2	Disadvantages of CNC Machine	6-3
6.2.3	Applications of CNC Machine	6-3
6.3	Basic Components of NC/CNC Machine	6-4
6.3.1	CNC Axis of Motion.....	6-6
6.3.2	Axes of CNC Machine	6-6



6.4	Classification of NC/CNC Machines..... 6-7	6.5.7	Threading and Grooving Cycle (Canned Cycles)...6-17
6.5	CNC Programming 6-9	6.5.8	Subroutines and Do Loops.....6-17
6.5.1	Steps in Developing Manual CNC Part Programs 6-10	6.5.9	CNC Part Programming for Lathe Machine6-18
6.5.2	Computer Assisted Part Programming..... 6-10	6.5.10	Part Program for Drilling6-25
6.5.3	NC Words 6-11	6.5.11	Rectangular Pocket Milling.....6-28
6.5.4	Part Programming Formats 6-11	6.5.12	Milling Operation6-29
6.5.5	G-Codes with their Functions 6-11	➤	Multiple Choice Questions (MCQ's) For Practice M-1 TO M-26
6.5.6	Miscellaneous Functions (M) Codes with their Functions 6-13		

