

Module 1

Chapter 1 : Introduction to Metal Cutting and Dynamometry 1-1 to 1-60

Syllabus :

- 1.1 Metal Cutting Theory :** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant’s force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant’s model & modified model for orthogonal cutting, problems on above topic.
- 1.2 Dynamometry :** Dynamometer requirements, force measurement, electric transducers, strain gauge lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, piezoelectric dynamometry

1.1	Metal Cutting Theory	1-1
1.1.1	Orthogonal Metal Cutting.....	1-2
1.1.2	Oblique Metal Cutting.....	1-3
1.1.3	Difference between Orthogonal Cutting and Oblique Cutting.....	1-4
1.2	Various Types of Chips	1-5
1.3	Mechanics of Orthogonal Metal Cutting.....	1-9
1.3.1	Shear Plane	1-9
1.3.2	Shear Plane Angle.....	1-10
1.3.3	Cutting Forces in Orthogonal Cutting.....	1-13
1.4	Theory of Ernst and Merchant (Ernst-Merchant 1st Theory).....	1-14
1.5	Modified Model for Orthogonal Cutting(Ernst-Merchant 2nd Theory)	1-18
1.6	Merchant’s Force Circle	1-20
1.6.1	Assumptions for Merchant Circle Diagram.....	1-20
1.6.2	Merchant’s Circle Diagram	1-20
1.6.3	Procedure to Draw Merchant Circle.....	1-24
1.7	Stresses	1-25
1.8	Shear Strain	1-26
1.9	Rate of Strain	1-28

1.10	Energy Consideration in Metal Cutting	1-29
1.11	Velocities in Metal Cutting and Their Relationship	1-31
1.12	Ernst and Merchant’s Relationship	1-34
1.13	Lee- Shaffer’s Relationship	1-35
1.14	Concept of Specific Power Consumption in Machining	1-35
1.15	Dynamometry	1-39
	1.15.1 Force Measurement.....	1-40
1.16	Electric Transducer	1-46
	1.16.1 Difference between Active Transducer and Passive Transducer.....	1-47
1.17	Construction and Working Principle of Some Common	
	Tool-Force Dynamometers	1-47
1.18	Strain Gauge Lathe Dynamometer	1-48
1.19	Strain Rings	1-49
1.20	Turning Dynamometer	1-55
1.21	Drilling Dynamometer	1-57
1.22	Milling Dynamometer	1-58

Module 2

Chapter 2 : Temperatures in Metal Cutting and Cutting Fluids

2-1 to 2-25

Syllabus : Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work tool thermocouple, direct thermocouple measurement, radiation methods, hardness changes in steel tools, Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, dry cutting and minimum quantity lubrication, cryogenic cooling, cutting fluid maintenance and environmental considerations, disposal of cutting fluids.

2.1	Introduction	2-1
	2.1.1 Heat Generation in Metal Cutting.....	2-2
	2.1.2 Heat Transfer in a Moving Material.....	2-5



2.1.3	Temperature Distribution in Metal Cutting.....	2-6
2.1.4	Effect of Cutting Speed on Temperature	2-8
2.1.5	Prediction of Temperature Distribution in Machining	2-9
2.2	Measurement of Cutting Temperature.....	2-10
2.2.1	Methods of Cutting Temperature Measurement	2-10
2.3	Hardness Changes in Steel Tools	2-14
2.4	Cutting Fluid.....	2-15
2.4.1	Types of Cutting Fluid.....	2-15
2.5	The Action of Coolants.....	2-16
2.6	The Action of Lubricants	2-17
2.7	Characteristics of an Efficient Lubricant in Metal Cutting	2-18
2.8	Application Methods of Cutting Fluid	2-19
2.9	Cutting Fluid Maintenance and Environmental Considerations	2-22
2.9.1	Environmental Considerations.....	2-24
2.10	Disposal of Cutting Fluids.....	2-24

Module 3

Chapter 3 : Cutting Tool Materials and Machining Induced Surface Integrity 3-1 to 3-37

Syllabus :

- 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond, polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools, Techniques for manufacturing coated tools
- 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish.

3.1	Cutting Tool Materials	3-1
3.1.1	Properties of Cutting Tool Materials.....	3-1
3.1.2	Major Tool Material Types	3-10
3.1.3	Coated Tools	3-21



3.1.4	Techniques for Manufacturing Coated Tools	3-22
3.1.4.1	Difference between CVD and PVD.....	3-25
3.2	Measurement and Specification of Surface Finish	3-25
3.2.1	Important of Surface Finish	3-25
3.2.2	Principle Elements of Surface	3-26
3.2.3	Surface Finish Measurement Technique/ Method	3-27
3.3	Cutting Edge in Cutting tool and its Types	3-33
3.4	Fracture Roughness	3-34
3.5	BUE Formation and its Influence on Finish	3-35

Module 4

Chapter 4 : Tool Life and Machining Economics
4-1 to 4-22**Syllabus :**

- 4.1 Definition, tool wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, machinability of material, factors affecting machinability.
- 4.2 Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate, problems on above topic.

4.1	Introduction to Tool Life	4-1
4.1.1	Tool Wear	4-1
4.1.1.1	Tool Wear Mechanisms.....	4-2
4.1.2	Criteria for Tool Failure	4-6
4.1.3	Effect of Cutting Parameters and Tool Geometry on Tool Life	4-9
4.1.4	Taylor's Tool Life Equation	4-10
4.1.5	Machinability of Material & Factors Affecting Machinability.....	4-11
4.2	Components of Product Cost.....	4-12
4.2.1	Optimum Cutting Velocity for Minimum Cost of Production	4-14
4.2.2	Optimum Cutting Velocity for Maximum Production Rate	4-15



Module 5

Chapter 5 : Design of Single Point Cutting Tools**5-1 to 5-39**

Syllabus : Different systems of tool nomenclature like MRS and ORS, Constructional features of solid tool, tipped tools, mechanically held regrindable insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders, Tool design for EDM and USM

5.1	Different Systems of Tool Nomenclature like MRS and ORS	5-1
5.1.1	MRS System of Tool Nomenclature	5-1
5.1.2	ORS System of Tool Nomenclature	5-3
5.1.2.1	Tool Nomenclature in ORS system	5-6
5.2	Tipped Tool	5-10
5.3	Mechanically held Re-grindable Insert types Tool	5-10
5.4	Throwaway Tip Type Tools.....	5-11
5.5	Design of Shank.....	5-13
5.6	Chip Breakers	5-16
5.6.1	Principles of Chip-Breaking	5-16
5.6.2	Design Principle of Simple Step type Chip Breaker.....	5-21
5.6.3	Configuration and Working Principle of some Chip Breakers in practice	5-22
5.7	Cutting Tip and Chip Breakers in Solid HSS tools.....	5-23
5.8	Cutting Tip and Chip Breakers in Carbide Tools	5-25
5.9	ISO Coding System for Tipped Tools and Tool Holder	5-27
5.10	Tool Design for EDM and USM	5-31
5.10.1	Tool Design for EDM.....	5-31
5.10.2	Tool Design for USM	5-37

**Module 6****Chapter 6 : Design of Multi-point Cutting Tools****6-1 to 6-26**

Syllabus : Introduction to various form tools, Broach nomenclature, design steps for circular pull type, key way and spine broaches, Design of face and peripheral milling cutters, Drill, Reamer and Tap design using standard procedure

6.1	Introduction to Various Form Tools	6-1
6.2	Broach Nomenclature.....	6-4
6.3	Design Steps for Circular Pull Type Broach.....	6-6
6.4	Design of Keyway Broach	6-9
6.5	Design of Splined Broach.....	6-12
6.6	Design of Face and Peripheral Milling Cutters	6-14
	6.6.1 Design Parameters of Peripheral/Face Milling Cutter	6-14
6.7	Design of Drill	6-16
6.8	Design of Reamer	6-18
6.9	Design of Tap Tools	6-22
	6.9.1 Design Features of Tap.....	6-22