MACHINING SCIENCE

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PRE-REQUISITES : Basic Manufacturing Engineering Courses

INTENDED AUDIENCE : Mechanical Engineering, Metallurgy, Aerospace Engineering, Production Engineering

INDUSTRIES APPLICABLE TO : All Manufacturing industries, Machine tool manufacturing industries, Automobile Industries and aeronautical industries

COURSE OUTLINE :

1. Introduction : Machining; Plastic Deformation, Tensile Test, Stress and Strain; Mechanism of Plastic Deformation: Slips, defects, plastic deformation on atomic scale.

2. Machining Process : Types of machining processes; Chip formation; Orthogonal and Oblique Cutting; Types of Chips; Built-up edge formation.

3. Tool Geometry : Reference planes; Tool specification: American System (ASA), continental or Orthogonal System (ORS), International or Normal Rake system (NRS); Tool angle relationships in ORS, ASA and NRS; Selection of Tool Angles; Multiple-point cutting tools: twist drill, helical milling cutter.

4. Mechanics of Metal Cutting : Merchant's Circle Diagram; Co-efficient of Friction: Determination of stress, strain and strain rate; Measurement of shear angle; Thin Zone model: Lee and Shaffer's Relationship; Thick Zone model: Okushima and Hitomi Analysis

5. Friction in Metal Cutting : Nature of sliding friction; Friction in Metal Cutting: Sticking and Sliding Zones, Analysis of Stress Distribution on the tool face: Zorev’s model; Determination of mean angle of friction.

6. Mechanism of Oblique cutting : Rake angles in oblique cutting: Analytical determination of Normal Rake angle, velocity rake angle and effective rake angle; their relationship; shear angles in oblique cutting; velocity relationship; Force relationships in oblique cutting.

7. Practical Machining Operations : Turning, shaping and planning, Slab milling, Drilling: Machining Parameters, force magnitudes, power consumption, material removal rate, time per pass.

8. Measurement of cutting Forces : Basic methods of measurement: Axially Loaded members, Cantilever Beam, Rings and Octagon, dynamometer requirements; machine tool dynamometers.

9. Tool Material, Tool Wear and Tool Life : Types of tool wear; Mechanisms of wear: Abrasion, Adhesion and Diffusion. Progressive tool wear: flank and crater wear. Tool Life: variables affecting tool life - cutting conditions, tool geometry, Types of tool materials, fabrication of cutting inserts, coatings, work material and cutting fluid; Machinability and their criteria.

10. Abrasive Machining Processes: Processes and analyses

11. Economics of Machining: determination of optimal cutting conditions for minimum cost, maximum production rate and maximum profit rate

12. Thermal Aspects of Machining: analytical determination of temperature in the shear zone and the chip-tool contact area

13. Surface finish: comparison and analytical determination of surface finish in turning, milling and grinding

ABOUT INSTRUCTOR :

Prof. Choudhury completed his Ph.D. in Mechanical Engineering from Moscow, Russia in 1985 followed by post-doctoral at the same university till 1986. From 1986 he has been involved in teaching and research in the Mechanical Engineering Department of Indian Institute of Technology Kanpur. His areas of specialization are conventional and non-conventional machining, automatic control, hydraulic control, machine tools and manufacturing automation.

COURSE PLAN :

Week 1 : Machining; Plastic Deformation, Tensile Test, Stress and Strain; Mechanism of Plastic Deformation: Slips, defects, plastic deformation on atomic scale; Types of machining processes; Chip formation; Orthogonal and Oblique Cutting; Types of Chips; Built-up edge formation; Tool specification; Tool angle relationships in ORS and ASA and NRS; Selection of Tool Angles; Multiple-pointcutting tools: twist drill, helical milling cutter.
Week 2 : Merchant's Circle Diagram; Co-efficient of Friction: Determination of stress, strain and strain rate; Measurement of shear angle; Thin Zone model: Lee and Shaffer's Relationship; Thick Zone model: Okushima and Hitomi Analysis; Nature of sliding friction; Friction in Metal Cutting: Sticking and Sliding Zones, Determination of mean angle of friction
Week 3 : Mechanism of Oblique Cutting: Normal Rake angle, velocity rake angle and effective rake angle; shear angles; velocity relationship; Force relationships in oblique cutting; Practical Marching Processes: Turning, shaping and planning, Slab milling, Drilling: Machining Parameters, force magnitudes, power consumption, material removal rate, time per pass.
Week 4 : Measurement of Cutting Forces: Basic methods of measurement: Axially Loaded members, Cantilever Beam, Rings and Octagon, dynamometer requirements; machine tool dynamometers; Types of tool wear; Mechanisms of wear: Abrasion, Adhesion and Diffusion. Progressive tool wear: flank and crater wear. Tool Life: variables affecting tool life - cutting conditions, tool geometry, Types of tool materials, fabrication of cutting inserts, coatings, work material and cutting fluid; Machinability and their criteria. Abrasive Machining Processes; Oblique Cutting; Economics of Machining; Thermal Aspects of Machining; Surface Finish.