Department of Mechanical Engineering
Indian Institute of Technology Kharagpur
End Semester Examination – Machine Tools and Machining (ME30604)

Full marks 80 **Time 3 hrs**

Attempt all questions

1 a. Draw a schematic diagram (top view) of a grooving operation performed on a lathe with a principle cutting edge angle of 90° in ISO Tool-In-Use System

b. For a single point cutting tool, the inclination angle is 10°. The master line of the rake surface is parallel to the auxiliary cutting plane. Determine the inclination angle of the auxiliary cutting edge.

c. The direction of rotation of the motor of a centre lathe is reversed. The direction of feed would not get reversed. Comment.

d. The increase in the feed leads to a reduction in dynamic yield shear strength. Comment.

e. The increase in the feed leads to increase in specific cutting energy. Comment. **2x5 = 10**

2 Draw the schematic diagram and state the generatrix and directrix statements for the following operations

a. face milling a horizontal surface in a vertical milling machine.
b. thread cutting in a CNC turning centre.
c. boring using a boring bar.
d. cylindrical traverse grinding using a tool post grinder in a lathe.
e. drilling a hole in a CNC turning centre.

2x5=10

3 a. Diamond is a suitable tool material for turning low carbon steel. Comment

b. The angle between cutting velocity vector and chip velocity vector is 95° in an orthogonal machining situation. Determine the orthogonal rake angle.

c. K10 grade of uncoated tungsten carbide is more suitable for finish turning as compared to K40 grade. Comment

d. Name at least 2 cutting tools for which HSS is still used in industry.

e. TiC coated carbide tool may provide wear resistance of P10 grade and toughness of P40 grade. Comment.

2x5 = 10

4 During orthogonal turning of a 100 mm diameter bar at a cutting velocity of 120 m/min and depth of cut of 2.5 mm, the feed rate is observed to be 38.2 mm/min. The observed (radial) thrust force is zero. The chip thickness is 0.25 mm. The rake angle is −10°. The specific cutting energy is 1.5×10^9 J/m^3. $\frac{P_x}{P_z} = 0.7$. Determine the following: (i) cutting power, (ii) shear angle, (iii) $\left(\frac{F}{N}\right)$, (iv) shear force and (v) dynamic yield shear strength.

10

5 a. Draw the free body diagram of a chip during chip formation.

b. During orthogonal turning ofa low carbon steel bar (dynamic yield shear strength of 650 MPa) at a cutting velocity of 120 m/min, the feed of 0.25 mm/rev and depth of cut of 4

mm, a chip thickness of 0.5 mm is obtained. The principal cutting edge angle and orthogonal rake angle are 75° and 10° respectively. Determine the contact length at the chip-tool interface. You need to take moment balance of forces present in the free body diagram of the chip.

3+7=10

6 The cutting velocity in an orthogonal turning is 2 m/s. It is also perpendicular to the chip velocity vector. Further, $\frac{a_1}{a_2} = 0.5$. The feed and depth of cut are 0.25 mm/rev and 4 mm, respectively. The uncut chip thickness is 0.25 mm. The angle between shear force vector and main cutting force vector is 30°. The dynamic yield shear strength of the work material is 500 MPa. The specific heat, density and thermal conductivity are 500 J/kg-K, 7800 kg/m^3 and 50 W/m-K. 15% of the heat generated at the shear plane is taken away by the workpiece and rest is taken away by the chip. Determine the rise in shear plane temperature.

10

7 a. Derive an expression for calculating the cycle time (or machining time per piece) in slab milling or face milling.

b. An annular disc of external diameter 200 mm, internal diameter 20 mm, thickness 75 mm is being faced using a CNC lathe at a constant cutting speed of 90 m/min. Feed and depth of cut employed for this operation are 0.2mm/rev and 2 mm, respectively. Calculate the time taken for a single pass.

3+7 = 10

8 a. Sketch a speed gear box having 18 speeds

b. Using a schematic show how a lathe having a metric lead screw having 6 mm pitch can be utilised to machine BSW thread having 4 TPI

c. Show a speed or feed reversal mechanism (using bevel gears).

4+ 3 +3=10