Department of Mechanical Engineering
Indian Institute of Technology Kharagpur
End Semester Question Paper of Machine Tools and Machining (ME30604)
April 2017

Full marks 80 Time 3 hrs

Attempt all questions

1 (i) Show two types of meander drives 5

OR

Show the layout of a eight speed gear box having sliding clutches (no sliding cluster gears)

(ii) The Norton cone has 13 gears. The first gear has 24 teeth and the numbers of teeth on the successive gears are in AP with a common difference of 2. The transmission ratios of the meander drive are 4, 2, 1 and 0.5. The number of teeth on the change gear quadrant are 20, 60, 15 and 30 where the gears with 60 and 15 teeth are on the same shaft. The numbers of teeth on both tumbler gears are 24. The transmission ratio between the meander drive abd leadscrew is 1. If the minimum pitch of a single start thread that can be cut in this lathe is 0.5 mm, find out the pitch of the lead screw. Also determine the maximum pitch of the single start thread that can be machined in this lathe. 5

2 The plane A (π_A) of single point turning tool (being used in a centre lathe) is at an angle θ from the auxiliary cutting plane towards the operator as measured on the reference plane. The same plane (π_A) is orthogonal to the reference plane and it is in between the orthogonal plane and auxiliary cutting plane. Find out the expression of the rake angle as measured on π_A as a function of orthogonal rake, inclination angle of the principal cutting edge and other relevant tool angles using graphical method. 10

3 Draw orthogonal section of a cutting tool showing rake, clearance, edge rounding radius, thickness of uncut layer and that chip, shear plane. Assume radius of edge rounding to be 25% that of thickness of uncut layer 3+7

There is single point turning tool without nose radius. The master line of the rake surface is parallel to the cutting plane. It is also perpendicular to the longitudinal feed direction. The side rake angle is -10 degree. The auxiliary cutting edge angle is 15 degree; the orthogonal clearance angles for the principal and auxiliary cutting edges are 8 degree each.

(i) Write down the tool specification in ORS or ISO-OLD system

(ii) Draw the top view of the tool. Show the relevant angles and position of master line.

(iii) In the sectional view, show the orthogonal rake angle, inclination angle

and orthogonal clearance angle

OR

Illustrate turning operation on a 10 mm wide cylindrical workpiece by (i) feed motion and (ii) feed-in motion. Which one of these is the non-formative operative motion? 10

A turning tool having principal cutting edge angle 60°, auxiliary cutting edge angle 60°, orthogonal rake 0°, inclination angle of principal cutting edge 0°, orthogonal clearance 5°, nose radius 0 mm is engaged in orthogonal turning with depth of cut 2 mm and feed 0.2 mm/rev. Determine front or end clearance angle of the cutting tool.

4 A low carbon steel bar is being turned by a single point turning tool having a nose radius of r, when the depth of cut is t, where $t \leq r(1 - \cos\varphi)$. The inclination angle is zero. Neglecting the effect of auxiliary cutting edge, determine the angle and sense (towards workpiece or tool) of chip deviation from the π_x plane. The principal and auxiliary cutting edge angles are 75^0 and 15^0, respectively. 10

5 A low carbon steel plate of 30 mm thickness is drilled with a HSS twist drill of 8 mm diameter. The rotational speed of the spindle is 300 rpm at a feed rate of 30 mm/min. The observed tool life is 24 min. When the rotational speed was increased to 600 rpm, the observed tool life is 12 min. What would be the tool life when the spindle speed is 400 rpm and feed rate is 40 mm/min? 10

OR

(i) Draw sketch to show the temperature profile at chip-tool interface.

(ii) What is meant by chip equivalent?

(iii) A turning tool having principal cutting edge angle 90°, auxiliary cutting edge angle 15°, rake 0°, nose radius 0 mm is engaged in orthogonal turning with depth of cut 2 mm and feed 0.2 mm/rev. Now feed is to be increased by 25% without any change in depth of cut. What should be the modified principal cutting edge angle in order that cutting temperature does not change? 2+2+6

6 The main cutting force vector, the resultant thrust force vector (P_{xy}), the friction force vector (at the chip tool interface) and the normal force vector (at the chip tool interface) form a square on the Merchant's circle diagram. The resultant cutting force (R) is $2000\sqrt{2}$ N. The cutting speed, feed and depth of cut are 2 m/s, 0.2 mm/rev and 5 mm. The chip thickness is 0.4 mm and the radial thrust force (P_y) is zero. The Kronenberg's equation is not valid. Determine the following: (i) the specific cutting energy (neglecting the contribution of feed force on power), and (ii) the dynamic yield shear strength. 10

7 In orthogonal machining, findout the ratio of main cutting force and 10

resultant thurst force for a ductile alloy and explain how will it vary with feed if the orthogonal rake is zero. The machining zone does not exhibit built up edge formation.

8

(i) An 8 mm HSS twist drill becomes blunt after drilling 398 holes in a steel plate of 18 mm thickness. What is its tool life if the cutting speed is 10 m/min and feed is 0.1 mm/rev? 5

OR

Draw orthogonal section of a fresh HSS cutting tool (rake 0° and clearance 10°) coated with 5 μm thick coating of TiN 5

Also, draw orthogonal section of the same cutting tool when it is worn. Show action of coating material retarding growth crater and flank wear even after exposure of the tool substrate.

(ii) An 80 mm wide and 500 mm long billet is being face milled by a 200 mm diameter and 100 mm long cutter having 12 teeth. The cutting speed is 120 m/min. The feed is 0.1 mm/tooth. Determine the machining time per pass if approach and over-travel are 5 mm each. 5