EX/PG/ME/T/112I/24/2017

MASTER OF ENGINEERING IN MECHANICAL ENGINEERING EXAMINATION, 2017

(1st Semester)

THEORY OF METAL CUTTING

Time: Three hours | Full Marks: 100

GROUP A

Answer ***Question No. 4*** and ***two more*** from this group.

Assume suitable data, if needed.

1. a) A turning tool has back rake angle of 8° and side cutting edge angle of 20°. Determine the side rake angle of this tool, if it is desired that inclination angle should be 0°. **Deduce the relationship used.** **(10)**

OR

Discuss about optimization of tool shape with respect to the following elements of tool geometry: rake angle, clearance angle, principal cutting edge angle, end cutting edge angle and nose radius. **(10)**

b) Distinguish between orthogonal cutting and oblique cutting with illustrative sketches. **(7)**

c) What is meant by chip equivalent? Mention about its significance. **(3)**

2. a) Determine the three components of the machining force during shaping a mild steel block with depth of cut 2.5 mm, feed = 0.125 mm/stroke, rake angle (for the purpose of force calculation) of the tool = 7°, side cutting edge angle = 10°, co-efficient of friction between chip and tool = 0.8 and ultimate shear strength of work material = 450 N/mm^2. Use Lee and Shaffer's shear angle relationship. **(10)**

b) Assuming that grinding temperature in surface grinding depends directly on the energy spent per unit surface area ground, show that the surface temperature of the work-piece (also the defects caused by higher temperature) can be reduced by decreasing d, D, C and N **or** by increasing table feed v_f, where d = depth of cut, D and N are respectively the diameter and rpm of the grinding wheel and C = no. of grits per unit area. (Expression of maximum uncut thickness involving various parameters **can be used without proof.**) **(10)**

3. a) Evaluate i) the optimum cutting speed for maximum production rate and ii) the tool life for maximum production rate, given that: tool changing time for every tool change = 2 minutes, tool life equation is $VT^{0.2} = 90$, where V is the cutting speed in m/min and T is the tool life in min. Consider turning operation of a cylindrical bar. **Deduce the relationship(s) used, if any.** **(10)**

b) Show in sketch flank wear, crater wear and indicate their parameters in the sketch. Also show graphically: i) flank wear growth over time ii) growth of crater wear parameters over time. Explain the different regions of the flank wear growth/curve. State about the limits of tool wear both for HSS and carbide tools. **(10)**

4. Answer ***any two*** of the followings: **(5x2 = 10)**

i) Discuss ***either*** about coated carbide(s) **or** about CBN as cutting tool material(s).

ii) Explain torque fluctuations during slab milling with a straight edged cutter, with relevant graphical presentation.

iii) Write a short note on surface integrity.

iv) Discuss about size effect with reference to grinding process. Also graphically show the relationship between radial depth of cut and normal force in grinding, indicating the different regions in the said context.

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GROUP B

Answer question no. 5 and any two from the rest in this group.

5. What are slip lines? With slip lines deduce an expression of maximum normal stress at the cutting edge of a wedge shaped cutting tool.

OR

Determine the locations of strain gauge placement on ring type dynamometer without cross sensitivity during measurement of two dimensional cutting forces. How are dynamometers calibrated, if at all there exists any cross sensitivity.

10

6. a) Deduce an expression correlating shear angle, friction angle and orthogonal rake angle considering thin shear zone and non uniform stress distribution on the rake surface in orthogonal cutting.

b) Briefly explain the stagnant phenomena on rake surface during chip formation.

16 + 4

7. a) Deduce an expression of kinetic coefficient of friction in the direction of chip flow in oblique cutting in terms of forces that can be measured by dynamometer.

b) How does overall cutting temperature vary with cutting velocity? Derive an expression of overall cutting temperature rise in terms of cutting velocity, depth of uncut layer and physical properties of workpiece material.

10 + 10

8. a) In a facing tool life test, the critical wear land of 1 mm was reached at 200 mm diameter at 250 rpm when the feed was 0.2 mm/rev. If the Taylor tool life exponent is 0.20, what is the value of constant C? Assume the cutting to start from the centre of the plate. Deduce the formula used.

b) Write a short note on types of chips and chip chart in machining.

16 + 4