Ref. No. : Ex/ME/5/T/511/2024(S)

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) FIFTH YEAR FIRST SEMESTER SUPPLEMENTARY EXAM – 2024

SUBJECT: METAL CUTTING AND MACHINE TOOLS

Time: 3 Hours **Full Marks: 100**

Assume any relevant data, if necessary. Symbols in the Question Paper carry their usual meanings. Figures in the margin indicate full marks. All Parts of any one question must be answered together.

Answer five (5) Questions taking at least two (2) from each group.

GROUP - A

Q1. a) Define "machining" and "machine tools".
b) How much time (in min) will be required to reduce the diameter of a cast iron rod from 116 mm to 112 mm over a length of 150 mm by turning at speed of 400 rpm and feed of 0.25 mm/rev?
c) State the purposes of determination of the magnitude of the cutting forces.
d) What are the possible harmful effects of the high cutting temperature on the cutting tools and workpieces? [5+5+5+5]

Q2. a) Distinguish between Orthogonal & Oblique cutting.
b) In orthogonal machining, prove that, $\tan\phi = \frac{r\cos\alpha}{1-r\sin\alpha}$, where, ϕ = shear plane angle, α = Rake angle, r = Chip thickness ratio or cutting ratio.
c) In orthogonal cutting operation, following data have been observed:
Uncut chip thickness = 0.127 mm, width of cut = 6.35 mm, Cutting speed = 2 m/s, rake angle = 10°, cutting force = 567N, Thrust force = 227N, chip thickness = 0.228 mm. Using merchant circle Diagram (MCD), calculate the following: (i) Shear angle, (ii) Friction angle, (iii) Shear stress, (iv) Cutting power, (v) Shear strain. [4+6+10]

Q3. a) What are the causes and effects of Built-Up-Edge (BUE) formation during machining of ductile material?
b) With a suitable sketch explain the chip formation mechanism in the machining of ductile material.
c) Why do chips of ductile metal become thicker after machining?
d) During turning a mild steel rod at a fee of 0.24 mm/rev by a carbide tool having an orthogonal rake angle of 10° and principal cutting edge angle of 30°, the chip thickness was found to be equal to 0.48 mm. Determine (i) the expected values of the chip reduction coefficient and (ii) the shear angle for this machining condition.
[6+6+3+5]

Q4. a) Derive Taylor's tool life equation and write the modified Taylor's tool life equation.
b) If in turning of a steel rod by a given cutting tool (material and geometry) at a given machining condition (feed and depth of cut) under a given environment (cutting fluid application), the tool life decreases from 80 min to 20 min due to an increase in cutting velocity from 60 m/min to 120 m/min, then at what cutting velocity the life of that tool under the same condition and environment will be 40 min?
[8+12]

[Turn over

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GROUP - B

Q5. a) State the purposes of machining. Explain Generatrix and Directrix with neat sketch for the following operations (any two): i) Shaping; ii) Drilling; iii) Turning.
b) State the relative advantages and limitations of hydraulic drive over conventional electro-mechanical drive in machine tool.
c) What are the different types of kinematic structure in machine tools? Sketch and explain Elementary Structure (E-22) and Complex Structure (C-12) of a Machine Tool. [(2+4)+5+(3+6)]

Q6. a) What is Ray Diagram in designing of a speed gear box? What are the characteristics of Ray Diagram?
b) Classify Ray Diagrams with examples and schematic diagrams.
c) If in a 12 speed centre lathe the velocity ranges from 40 m/min to 200 m/min and job diameter ranges from 50 mm to 200 mm, then determine the values of those 12 standard spindle speeds in GP. [6+4+10]

Q7. a) What is speed layout in designing a speed gear box (SGB) of a machine tool. Describe various aspects of speed layout.
b) State why GP (geometric progression) is preferred to AP (arithmetic progression) for the layout of spindle speeds in machine tools.
c) State the principle of fixation the value of the common ration (ϕ) during spindle speed layout in GP.
d) Justify the statement – in case of speed layout in AP, the maximum productivity loss increases with the increase in workpiece diameter 'D' as well as the values of common difference 'b'. [6+2+12]

Q8. a) What factors govern selection of the values of cutting velocity, feed and depth of cut while carrying out a turning operation in a lathe?
b) Design a 6 speed gear box for a drilling machine requiring speed variation between 140 and 450 rpm (Common ratio $\phi = 1.25$). The design of the gear box should include (i) drawing of gearing diagram, (ii) Finding out optimal Ray diagram. [8+12]

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