Ref. No.: Ex/ME(M2)/PC/B/T/413/2024(S)

B.E. MECHANICAL ENGINEERING FOURTH 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) Show by a suitable sketch the rake angle and clearance angle of any cutting tool in a machining work. Also, state why these angles are provided.

b) In orthogonal machining, prove that $\tan\beta=\frac{r\cos\gamma}{1-r\sin\gamma}$, where, β=shear plane angle, γ=Rake angle, r = Chip thickness ratio or cutting ratio.

c) Determine the values of the orthogonal rake angle (γ_o) and the inclination angle (λ) of the main cutting edge of the turning tool specified in the ASA system as 10° , - 10° , 8° , 6° , 15° , 30° , 0 (inch).

[7+6+7]

Q2. 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 (a) the expected values of the chip reduction coefficient and (b) the shear angle for this machining condition.

[6+6+3+5]

Q3. a) Distinguish between Orthogonal & Oblique cutting. Compute shear strain for orthogonal cutting.

b) What are the purposes of determining the magnitude and other characteristics of the cutting forces that develop during various kinds of machining work?

c) During pure orthogonal turning of a metal rod by a tool of the following geometry inclination angle (λ) = 0°, orthogonal rake (γ_o) = 0° and principle cutting edge angle (ϕ) = 90° - it was noted that the magnitude of the tangential component (P_z) and the axial component (P_x) of the cutting force are 600 N and 200 N respectively and the value of chip reduction co-efficient (ζ) is 1.732. Using MCD (Merchant's circle diagram) or without using MCD, determine the magnitude of the shear force P_s and the frictional force F for the above condition.

[(3+3)+4+10]

Q4. a) Derive Taylor's tool life equation and write the modified Taylor's tool life equation.

b) Under a given condition of turning, the tool life was found to decrease from 24 min to 16 min when only the cutting velocity V_C was raised from 200 m/min to 250 m/min. what will be the tool life if the cutting velocity is further increased to 300 m/min under the same machining condition?

c) Determine the actual machining time required to reduce the diameter of a rod from 200 mm to 195 mm over a length of 200 mm at a cutting velocity of 220 m/min and feed of 0.2 mm/rev. Assume, approach A = 5 mm and overrun O = 5 mm.

[7+7+6]

[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) Drilling; ii) Shaping; iii) Turning.
b) How can 'machine tool' be defined? Name the major components common to all conventional machine tools and the functions of those components.
c) What are the different types of kinematic structure in machine tools? Sketch and explain the Complex Structure (C-12) of a Machine Tool.

[(3+4)+5+(3+5)]

Q6. a) Name the mechanisms which transform rotary motion into translatory (or linear) motion in various machine tools. Also, state the advantages of those mechanisms.
b) What factors need to be considered while selecting the magnitude of cutting velocity and feed for any turning operation in lathes? Name the different commonly used methods of changing feed rate in conventional machine tools.
c) The lowest and the highest spindle speeds of a 12 speed milling machine are 10 rpm and 450 rpm, respectively. Determine the values of the other 10 spindle speeds if those speeds are in (i) AP and (ii) GP.

[5+5+10]

Q7. a) 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'.
b) What factor governs deciding the final values of the spindle speeds of a lathe or milling machine?
c) Design a speed gear box for a drilling machine requiring six spindle speeds with common ratio ϕ = 1.25. The design of the gear box should include (a) drawing the gearing diagrams, (b) Ray diagram.

[7+3+10]

Q8. a) State the advantages and disadvantages of CNC machine tool over conventional machine tool.
b) Name the different component of CNC machine tool and show their interrelation with a block diagram.
c) What is the difference between NC and CNC machine tools?
d) How does the stepper and servo motor functions in CNC machine tools?

[5+5+3+7]

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