BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING) FIFTH YEAR FIRST SEMESTER EXAM 2025

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 any five (5) Questions

Q1. (a) Define "machining" and "machinability". How "machinability" is judged?
(b) How much time will be required to reduce the diameter of a cast iron rod from 80 mm to 76 mm over a length of 120 mm by turning in a lathe at cutting velocity 140 m/min and feed 0.32 mm/rev?
(c) What are the different methods or ways of obtaining the lines Generatrix and Directrix in various machine tools? Explain with specific examples. (4+2)+6+8=20

Q2. (a) Illustrate the formation of chip. Discuss the types of chips with neat sketches.
(b) Prove that in metal cutting
i) $\xi = \frac{1}{r} = \frac{\cos(\Phi-\alpha)}{\sin\Phi}$, where, Φ= shear plane angle, α= Rake angle, r= Chip thickness ratio, ξ =chip reduction coefficient.
(c) The tool signature of a turning tool is given in ASA as 8°-7°-9°-8°-15°-30°-1/64". Identify each of these elements and draw necessary views to show them. 6+6+8=20

Q3. (a) Discuss about Merchant theory and derive the equation for minimum cutting force.
(b) During turning a steel round of 160 mm diameter at 560 rpm employing a feed of 0.32 mm/rev and depth of cut as 4 mm by a ceramic insert having nomenclature 0, –10°, 6°, 6°, 15°, 75°, 0(mm), the following observation were made
Cutting force = 1600 N, Thrust force = 828 N and chip thickness = 1mm
Using Merchant circle diagram (MCD), compute the following:
i) Friction force on tool rake face and corresponding normal reaction.
ii) Shear force and corresponding normal face
iii)Co-efficient of friction between tool-chip inter faces
iv) Cutting power 10+10=20

Q4. (a) Discuss about flank wear, crater wear with illustrative sketches.
(b) Explain the factors affecting tool life. Derive Taylor's tool life equation.
(c) Determine the values of the constant C and index n of Taylor's tool life equation for the turning tool whose life changes from 20 min. to 12 min. due to change of cutting velocity from 120 m/min to 160 m/min under a given machining condition. 6+6+8=20

Q5. (a) How does high cutting temperature affect the cutting tool performance and quality of the machined product? What properties should cutting fluids possess for desired functioning?
(b) What are the major factors that govern machining time?
(c) Determine the actual machining time that will be required to remove, by shaping, a layer of 2 mm thickness from a cast iron plate of length 100 mm and width 60 mm at cutting velocity of 40 m/min and feed of 0.2 mm/stroke. Assume approach and overrun along width = 2 mm and along length = 5 mm, quick return ratio of the shaping machine is 2/3. (4+4)+4+8=20

Q6. (a) List the major procedural steps to be followed in sequence while designing a speed gear box of any centre lathe.

(b) With a specific example, explain what are meant by gear layout and Ray diagram of a speed gear box of a lathe. State the criteria for selection of optimum ray diagram.

(c) What is productivity loss of a machine tool? Calculate maximum productivity loss between two spindle speeds (in GP) of 360 rpm and 285 rpm. Deduce the equation used for the calculation.

6+6+8=20

Q7. (a) A centre lathe having 12 spindle speeds has been designed for machining jobs of diameter ranging from 40 mm to 120 mm at cutting velocity in between 50 m/min and 200 m/min. Determine the standard spindle speeds of that lathe?

(b) Design a speed gear box for a Centre Lathe requiring six spindle speeds with common ratio $\varphi=1.25$ ($\cong 2^{1/3}$) The design of the gear box should include i) drawing the gearing diagrams, ii) Ray diagram.

8+12=20

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