Ref. No.: Ex/ME/5/T/511/2024

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

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.

GROUP-A

Q1. Choose the correct alternative 10×2=20

(i) Taylor's tool life equation is expressed by
(a) $TV^n = C$ (b) $VT^n = C$ (c) $(VT)^n = C$ (d) $VT = C$

(ii) The composition of commonly used HSS is
(a) 18W 4Cr 1V (b) 12Mo1W 4Cr 1V (c) 6Mo 6W 4Cr 1V (d) none of these

(iii) Cutting fluid is employed in turning steel rods by carbide tools for
(a) reducing cutting forces only (b) reducing cutting temperature only
(c) increasing tool life only (d) all of the above

(iv) Mechant's circle diagram (MCD) is valid for
(a) orthogonal cutting only (b) oblique cutting only
(c) both orthogonal and oblique cutting (d) none of the above three

(v) Both the cutting motion and the feed motion are imparted to the cutting tool while
(a) turning in a lathe (b) drilling in a drilling machine
(c) milling in a milling machine (d) shaping in a shaping machine

(vi) The maximum amount of heat that is generated at the cutting zone during machining goes to the
(a) Cutting tool (b) Workpiece (c) Chip (d) none of these

(vii) Life of any cutting tool does not depend upon
(a) Tool material (b) Tool geometry (c) Cutting fluid application (d) None of the above

(viii) If all the kinematic chains are interconnected (or interdependent) in any machine tool then its kinematic structure will be called
(a) Elementary type (b) Complex type (c) Compound type (d) Combination type

(ix) If the structure formula of a gearbox design is z = 2(1) 3(2) 2(6), then the approximate number of gears required will be _____.
(a) 6 (b) 12 (c) 14 (d) 16

(x) For the same tool-work material combination in a lathe work, the highest cutting velocity can be taken while
(a) Straight turning (b) Thread cutting (c) Reaming (d) Knurling

GROUP-B

Answer any four (4) Questions

20×4=80

Q2. (a) Define "machining" and "machinability". How "machinability" is judged?

(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?

[Turn over

(c) What are the sources of Generatix and Directrix? Explain Generatrix and Directrix with neat sketch for operations: i) Drilling ii) Turning. (4+2)+6+(4+4)=20

Q3. (a) Define with neat sketch Shear plane and Shear angle. 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.

(b) Draw a single point turning tool (SPTT) and show on it tool signature parameters in ASA.

(c) An orthogonal turning operation is carried out at 20 m/min cutting speed, using a cutting tool of rake angle 15°. The chip thickness is 0.4 mm and the uncut chip thickness is 0.2 mm. Determine (i) the shear plane angle in degrees, and (ii) the chip velocity in m/min. (4+5)+ 5+6=20

Q4. (a) For minimum energy consumption during orthogonal cutting, establish the relationship between the shear angle (ϕ), friction angle (λ), and rake angle (α) as per Ernst Merchant Theory (Merchant's first solution).

(b) Mild steel is being machined at a cutting speed of 200 m/min with a tool rake angle of 10°. The width of cut and uncut thickness are 2 mm and 0.2 mm, respectively. If the average value of co-efficient of friction between the tool and the chip is 0.5 and the shear stress of the work material is 400 N/mm^2, then using Merchant's first solution, determine: (i) The shear angle, (ii) Cutting and thrust components of the force. 10+10=20

Q5. (a) The following equation for tool life is given for a turning operation: $V.T^{0.13}.f^{0.77}.d^{0.37}=C$. A 60 minute tool life was obtained while cutting at V=30 m/min, f=0.3 mm/rev and d=2.5 mm. Determine the change in tool life if the cutting speed, feed & depth of cut are increased by 20% individually & also taken together.

(b) Determine the actual machining time that will be required for plain milling a rectangular surface of length 200 mm and width 50 mm by a helical fluted plain HSS milling cutter of diameter 70 mm, length 75 mm and 6 teeth. Assume A= O = 5 mm, V = 44 m/min and s_0 = 0.2 mm/tooth. 10+(5+5)=20

Q6. (a) Define machine tool. What is the need of large number of speeds in machine tools?

(b) Name three each the mechanisms used for transforming rotation to rotation and from rotation to translation in conventional machine tools. Sketch and explain Elementary Structure (E-22) and Complex Structure (C-12) of a machine tool.

(c) State why GP (geometric progression) is preferred to AP (arithmetic progression) for layout of spindle speeds in machine tools.

(d) 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. What should be the lowest and the highest spindle speed of that lathe? (2+3)+(3+4)+3+5=20

Q7. (a) State the principle of fixation of the value of the common ratio (ϕ) during spindle speed layout in GP.

(b) List the major procedural steps to be followed in sequence while designing a speed gear box (SGB) of a machine tool.

(c) Design a 6 speed gear box (SGB) to give output speeds ranging between 200 rpm and 600 rpm. Draw the kinematic arrangement of gears and suitable ray diagram of the gear box. 4+4+12=20