DEPARTMENT OF MECHANICAL ENGINEERING

Master of Mechanical Engineering Examination
(1st Semester)
Subject : Theory of metal cutting

Full Marks : 100 *Time: 3 Hours*

ANSWER ANY FIVE QUESTIONS

Assume any data if needed

Q1 (a) During orthogonal machining with a cutting tool having a 8^0 rake angle, the chip thickness is measured to be 0.3mm, the uncut thickness being 0.15mm. Determine the shear plane angle and also the magnitude of the shear strain. [8]

(b) A straight turning tool has a back rake angle γ_y of 8^0 and side cutting edge angle ϕ_s of 30^0. What value of side rake angle γ_x should be taken for achieving orthogonal cutting condition? [8]

(c) What are the differences between orthogonal cutting and oblique cutting [4]

Q2. (a) Prove that

$$\frac{V_C}{V_f} = e^{\mu\left(\frac{\pi}{2}-\gamma_o\right)} = \xi$$

Where
V_c = cutting velocity
V_f = Chip velocity
γo = orthogonal rake
ξ = chip reduction coefficient
What does this relationship signify? [10]

(b) Explain the mechanism of chip formation in brittle material. [10]

Q3. (a) Give the tool signature in ASA system and show the relevant views of a single point turning tool to present the tool geometry in each of the system. [14]

(b) Define "effective rake". How does nose radius of a cutting tool influence the machining process? [3+3]

Q4. (a) Discuss the Merchant theory for shear plane angle in orthogonal cutting [5]

(b) During turning a ductile alloy by a tool of γ_0 =10^0, it was found P_Z =1000N, P_X =400N, P_Y =300N and ξ =2.5. Evaluate, using MCD, the values of F, N and μ as well as P_S and P_n for the above machining. [15]

Q5. (a) Mild steel is being machined at a cutting speed of 200m/min with a tool rake angle 10^0. The width of cut and uncut thickness are 2mm and 0.2 mm, respectively. If the average value of the coefficient of friction between the tool and chip is 0.5 and the shear stress of the material is $\tau_s = 400\ N/mm^2$, determine (i) the shear angle and (ii) the cutting and thethrust components of the machining force. [15]

(b) Explain: "Torque fluctuation during slab milling with a straight edge cutter", along with relevant- graphical presentations. [5]

Q6. (a) What are meant by "ideal surface roughness" and "natural surface roughness"? Also, graphically show the influence of cutting speed on ideal roughness and total roughness. [6]

(b) When turning a cylindrical work piece, two different tools are used. In one tool, no nose radius is provided, the side cutting and the end cutting edge angles being 30^0 and 7^0, respectively. In the other tool, a nose radius of 0.7mm is provided. The feed used in both the cases is 0.125mm. Find out the maximum height of unevenness in the generated surfaces. [14]

Q7. (a)Give the tool signature in ORS and show the relevant views of a single point turning tool to present the tool geometry in that system. [14]

(b) Discuss about carbides and coated carbides as cutting tool materials. [6]