ASSIGNMENT - 1

Prob. 1. During turning a mild steel component with an orthogonal tool a feed of 0.75 mm/rev is used at 50 rpm. If the chip thickness is 1.5 mm, determine the chip thickness ratio. Also find the length of chip removed in one minute if the work diameter is 50 mm before the cut is taken. Assume a continuous chip is formed. (0.5, 3927 mm/min)

Prob. 2. In an orthogonal turning operation, cutting speed V_c = 80 m/min, feed force P_x = 8 kgf., cutting force P_z = 20 kgf., orthogonal rake angle $\gamma = 15^o$, feed f = 0.2 mm/rev, chip thickness a_2 = 0.4 mm, Determine the following:
a) Shear angle b) Work done in shear c) Shear strain (29^o, 1084 kgf-m/min, $\varepsilon_s = 2.053$)

Prob. 3. In an orthogonal cutting if the feed is 1.25 mm/rev, the chip thickness after the cut is 2 mm, rake angle = 10^o, shear strength (ultimate) of the metal = 6000 kgf/cm^2, width of cut = 10 mm, cutting speed = 30 m/min, co-efficient of friction = 0.9. Determine the following:
a) Shearing force, b) Friction angle, c) Cutting force, d) Horse power consumed at the cutting tool. (F_s = 1320.78 kgf, $\eta = 42^o$, 2821.2 kgf, 18.81 HP)

Prob. 4. In orthogonal cutting of a material the feed force is 80 kgf., cutting force is 150 kgf., chip thickness ratio is 0.3 and rake angle is 8^o. Calculate the following:
i) Compression and shear forces on shear plane, ii) Co-efficient of friction of the chip on the tool face. (N_s = 121 kgf, F_s = 119.4 kgf, $\mu = 0.728$)

Prob. 5. To turn a mild steel component, the power requirement (specific energy required) is 0.1 HP/cm^3/min. The maximum power available at the machine spindle is 5 HP. If the cutting speed is 35 m/min and feed rate is 0.25 mm/rev, determine the following:
a) max. metal removal rate, b) depth of cut, c) cutting force, d) normal pressure on chip
(50 cm^3/min, 5.7 mm, 642.86 kgf, 451 kgf/mm^2)

Prob. 6. The power required by a lathe when running idle is 300 watts. The power input rises to 2400 watts when an alloy steel is machined on lathe at 120 rpm. If the depth of cut is 3.5 mm, feed is 0.2 mm/rev and cutting speed is 24 m/min, calculate the following:
a) Cutting force and torque at the spindle, b) HP/cm^3/min required to cut the material
(P_z = 527.8 kgf, T = 16.8 kgf-m, 0.1675 HP/cm^3/min)

Prob. 7. During a metal cutting test under orthogonal condition it was found that cutting force is 110 kgf and feed force is 102 kgf when cutting at 165 m/min. The rake angle of the tool is 10^o and shear plane angle is 19^o. Determine the following:
a) Shear velocity, b) Chip flow velocity, c) Work done per min in shearing and against friction, d) Show that the work input is (approximately) equal to the sum of (W_s & W_f) work done in shearing and against friction.
(Ans. V_s = 164.52 m/min, V_f = 54.4 m/min, W_s = 11647.86 kgf-m, W_F= 6503.612 kgf-m)

Prob. 8. In orthogonal cutting of a MS tube of 150 mm diameter and 2 mm thick, the cutting force was observed to be 130 kgf and feed force 35 kgf and chip thickness 0.3 mm. The orthogonal cut was taken at 60 m/min with a feed of 0.15 mm/rev. If the rake angle of the cutting tool was -8^o, Calculate the following:
a) Shear strain, b) Strain energy per unit volume. (2.805, 405.62 kgf/mm^2)

Prob. 9. During machining C-25 steel with 0-10-6-7-8-90-1mm ORS shaped carbide cutting tool, the following observation have been made: Feed = 0.18 mm/rev, depth of cut = 2 mm, cutting speed = 150 m/min, P_z =160 kgf, P_x = 80 kgf, chip thickness = 0.4mm.
Determine: a) Chip reduction co-efficient, b) Shear force and normal force at shear plane, c) Kinetic co-efficient of friction. d) Specific energy of friction.
(2.22, 109.55 kgf, 141.41 kgf, 0.74, 133.21 kgf/mm^2)

Prob.10. During orthogonal cutting of a MS tube at 15 m/min, using a 15^o rake HSS tool, the following data were recorded: Chip thickness ratio = 0.35, Co-efficient of friction = 0.6.
The friction force on the tool chip interface was measured by means of a special set up as 48 kgf. Determine the components of the cutting forces, shear angle, shear strain and work done in deformation. (P_z = 89.7 kgf, P_{xy} = 25.65 kgf, Ws = 1132.42 kgf-m/ min)

Prob. 11. Show that: $P_z = \dfrac{\tau_s.\varepsilon.A_1}{1-\left\{\dfrac{r\sin\eta}{\cos(\eta-\gamma)}\right\}}$

Prob. 12. Show that in orthogonal cutting with zero rake, the ratio of shear strength to the specific cutting energy is given by: $\dfrac{\tau_s}{E_c} = \dfrac{(1-\mu r)r}{1+r^2}$

Prob. 13. Show that when cutting metal (orthogonal) with a tool of zero rake angle, the heat generation in the shear zone is given by, $H_s = P_z V_c (1-\mu r)$.

Prob. 14. During an orthogonal machining, the following observations were made: V_c = 150 m/min, f = 0.4 mm/rev, a_2 = 0.8 mm, $\varphi = 60^o$, $\gamma = 15^o$. Evaluate (i) shear strain during metal failure (ε_s), (ii) the rate of shear strain ($\dot{\varepsilon}_s$), if the thickness of the shear zone is measured as 9 μm. (2.32, 2.7×10^5 s^{-1})

Prob. 15. The following is recorded in a turning operation: V_1 = 20 m/min, T_1 = 70 min, V_2 = 45 m/min and T_2 = 9 min. Determine the expected tool life of the tool for a cutting speed of 40 m/min. (12.145 min)

Prob. 16. The tool life relationship for HSS tool is $VT^{0.123} = C_1$ and the same for carbide tool is $CT^{0.21} = C_2$. Assuming that at a cutting speed of 25 m/min the tool lives are same, compare their tool lives at 35 m/min. (Tc/Th = 3.106)

Prob. 17. The following equation for tool life is given for a turning operation: $VT^{0.13}f^{0.77}d^{0.37} = C$. A ’60-min’ 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 and depth of cut are increased by 20% at a time. (95% reduction)

Prob. 18. Prove that the strain energy per unit volume is the product of shear stress and shear strain.

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