ME 338
Tutorial#1
HW#3

1. You are performing a turning operation on a lathe, which reduces a part's diameter. The work piece has an initial diameter of 75 mm and a final diameter of 73 mm. The axial length of the cut is 225 mm. The motor is rated at 35 kW. It can operate with 90% efficiency. The arithmetic average (AA) surface finish is required to be 25 microns (1 micron = 10^{-6} meters). The arithmetic average $= \frac{f^2}{r18\sqrt{3}}$ (where f is feed/rev and r is tool radius). Use the average diameter to approximate the cutting speed for this entire problem. Determine the time to perform the cut.

   <u>For the metal being cut:</u>
   Specific cutting energy (u) = 1.5 W-s/mm^3
   Edge radius, r = 0.1 mm.

2. A 400-mm long, 25 mm diameter titanium- alloy rod (u = 3.5 W-s/mm^3) is being reduced in diameter to 23 mm by turning on a lathe. The spindle rotates at 3500 rpm, and the tool is traveling at an axial velocity (feed) of 0.08 mm/rev. Calculate the cutting speed, material removal rate, time of cut, power required, and cutting force.

3. During an orthogonal machining operation results are obtained as:
   Uncut chip thickness, t_0 = 0.25 mm, chip thickness, t_c = 0.75 mm, w = 2.5 mm
   α = 0 deg, Fc = 950 N, Ft = 475 N.
   Determine the coefficient of friction between tool and chip
   Determine the ultimate shear stress of work material

4. A steel bar is orthogonally cut with a tool with rake angle = 15 deg. The depth of cut = 1mm and width of cut = 30 mm. The Workpiece velocity is 2 m/s. The cutting force is 150 N and thrust force is 25 N. Determine the shear strength of cutting material and chip thickness. (Hint: Use Merchant's relationship: $\phi = \frac{\pi}{4} - \frac{(\beta - \alpha)}{2}$)

5. Mild steel is being orthogonally turned at an average cutting speed of 280 m/min with a rake angle of 10^0. The depth of cut (change in radius before and after machining) is 2 mm and feed (undeformed chip thickness) is 0.2 mm/rev. The average value of the coefficient of friction between tool and chip is 0.5 and the shear stress τ_s of the work material is 400 N/mm^2. Determine:
   a) Shear angle
   b) The cutting and thrust forces
   Merchant's equation,
   $2\phi + \beta - \alpha = \pi/2$