MEL769 METAL FORMING ANALYSIS
Major Test, 2006

Time : 2 hours Max marks: 65

1. a) UTS of a material is 300 MPa and it elongates 35% to reach maximum load in a uniaxial tensile test. Determine the plastic stress-strain relation of the material if it obeys power law of strain hardening. (7)
   b) Derive Levy-Mises equations for rigid perfectly plastic solids. (8)

2. State the upper bound theorem. Using upper bound method, derive an expression for pressure required for plane strain compression of a rectangular billet in terms of shear yield stress (k) and *l/h* ratio assuming a flow field as shown in Fig. Consider sticking friction at the die-work interface. Compare the pressure with the slab analysis if the length is 1.5 times the height. (12)

3. A 300mm wide Al alloy strip is cold rolled to reduce thickness from 5mm to 3mm. These rolls are 1m in diameter and operate at 200 rpm. The uniaxial flow stress of the alloy can be expressed as $\sigma = 140\varepsilon^{0.2}$ (MPa). Determine the rolling load, torque and the power required for this reduction if $\mu = 0.2$ and $\lambda=0.45$. (10)

4. Derive an expression for the force required to bend a sheet of thickness t and width w through an angle θ under plane strain condition in a V-die with a die opening width of 2L. Assume the material to be rigid-ideal plastic with uniaxial yield strength σ_0. Show that this force will be maximum when $\theta = 0.5\ (\tan^{-1}\mu)$ where μ is the coefft. of friction between die and the sheet. (8)
   b) If elastic portion is considered in the above problem, show the residual stress distribution in the through thickness direction due to spring back. (2)

5. A cylindrical cup of 60mm diameter and 90mm height is to be drawn from a circular blank of thickness 1.5mm. Calculate the blank size. If these circular blanks are cut from a large sheet, calculate the force and power required for blanking (15 blanks have to be sheared in a minute). UTS of the material is 175 MPa. Assume 60% punch penetration. What should be the blanking die and punch diameters assuming 4% clearance? (8)

6. Draw **labeled figures** to show the following: (10)
   a. The distribution of roll pressure along the arc of contact and the effects of front and back tensions in strip rolling.
   b. Variation of ram pressure with stroke in forward and backward extrusions.
   c. Stresses acting on an element in the deformation zone in wire drawing.
   d. Von Mises yield locus for a plane stress system and show the effect of anisotropy on drawability.
   e. Comparison of strain distribution in annealed and cold worked sheets if stretch formed to the same depth.

Fig.