Menofia University	Mech Design and Prod. Eng. Dept
Second term-time: 3hrs	Post Graduate Master Level 600
Theory of Plasticity	Date: 18/06/2014 Total mark: 100

Answer all the following questions:

Question No.1

Show that for a simple homogenous, cylindrical extrusion the force acting upon the ram is given by: $F = YAr\ ln\ (Ar/Ae)$ where Ar is the area of the ram, Ae the area of the extruded bar and Y is yield stress for rigid-plastic material. In a two-stage, extrusion process a 20 mm billet is first produced from a 10% reduction to its original area. There after, the billet is extruded to 18 mm. Given that the true stress-natural strain law for the annealed material is expressed by a Hollomon law: $\sigma = 980\varepsilon^{-.019}$, determine necessary for extrusion accounting for work Hardening.

Question No.2

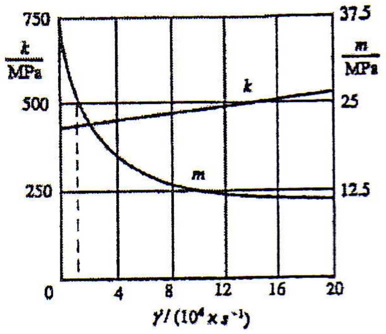
Estimate the roll force and torque required to roll a 300 mm wide, annealed sheet from 4 mm to 3.5 mm thick between two rolls each of radius 175 mm. How is the force altered when the original area had been attained by a previous reduction of 10%? The plane strain, true stress versus natural strain curve is given by:

$$\sigma = K(A + \varepsilon^{p})^{n} \quad \text{or} \quad \frac{\sigma}{\sigma_0} = \left(1 + \frac{\varepsilon^{p}}{\varepsilon_0}\right)^{n}$$

In which $\sigma_0 = 2k = 200$ MPa, $\varepsilon_0 = 0.05$ and $n = 0.25$.

Question No.3

The conditions when orthogonal machining a work hardening material are: rake angle $\alpha = 10°$, cutting speed $v = 0.5$ m/s and depth of cut $b = 0.2$ mm. Assume an experimental value $\phi = 25°$ for the shear angle with a rectangular shear zone of aspect ratio 10:1. Calculate the shear strain, the shear strain rate, and the inclinations of the resultant force R to the flank face and to the shear plane. Use the flow properties for the material given in the below figure.

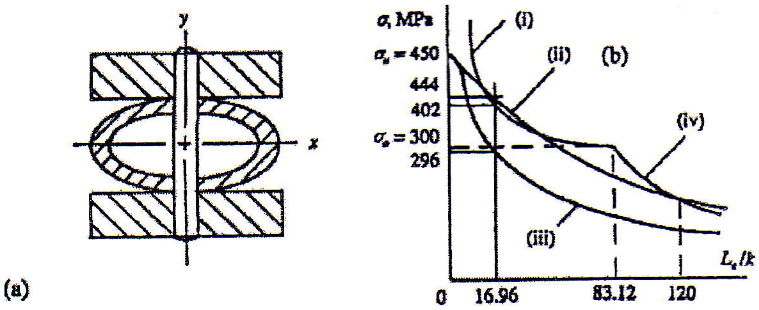


Question No.4

Apply this equation ($\tau = \frac{F\cos\lambda}{A/\cos\phi} = \sigma\cos\phi\cos\lambda$) to show when a tensile stress σ is applied to a single crystal, the critical resolved shear stress τ_{cr} is at a maximum for $\phi = \lambda = 45°$. Plot the variation in τ_{cr}/σ when the slip plane is inclined at various angles to the stress axis.

Question No.5

An 800 mm long steel strut has a thin-walled, elliptical cross-section shown in Fig. The mean lengths of the major and minor axes are 80 and 30 mm respectively and the wall thickness is 3 mm. At its end fixings, Fig. 12.4a shows that the strut is free to rotate about a pin aligned with its y-axis but it is prevented from rotating about its x-axis by the rigid walls shown. Compare the allowable compressive plastic loads according to the Engesser, parabolic and Rankine-Gordon formula, using a safety factor of 1.5. For steel take $\sigma_0 = 300$ MPa, $\sigma_u = 450$ MPa, E = 210 GPa and n = 1/3.



Question No.6

A 320 mm square steel plate is 7 mm thick. It is simply supported along all sides and carries a uni-axial compressive stress. Determine the critical elastic and plastic buckling stresses. What is the influence of clamping the unloaded sides upon the plastic buckling stress? Take: E = 210 GPA, Y = 310 MPa, $\sigma_n = 450$ MPa, ν= 0.27 and m = 5.

****************** GOOD LUCK *******************

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