B. E. METALLURGICAL AND MATERIAL ENGG. EXAMINATION, 2019

(4th Year, 1st Semester)

METAL WORKING PROCESSES

Time : Three hours | Full Marks : 100

Answer Any Five Questions. All carry equal marks

1. (a) What is Principal stress and Principal strain? State Von mises and Tresca criteria for yielding. Why these are required? How do those differ? Why deviotoric stress of a stress system is more important than hydrostatic stress though the latter is higher?
(b) How Mohr's circle of stress is derived from analyzing the stress field? In metal working state its importance. Draw Mohr circle of stress for following operations (i) Pure Shear (ii) Biaxial System of Stress (σ_1=-2σ_2), (iii) Rolling with Tension, (iv) Close Die forging with Flash.

2. (a) Deduce the relationship between Elastic Modulus and Elastic strain in x, y, z axial directions. Deduce the relationship between Elastic Modulus and Shear Modulus. Why Shear modulus is important? What is Bulk modulus?
(b) One low-carbon steel, one high carbon steel and one Aluminum sheet forming had taken place. Which would have high spring back and why? You have bent two low-C steel sheets into two different angles. Which sheet will have more spring back? You are asked to get 1mmϕ wire by cold drawing. Comment whether Wire drawing Die hole should have 1^+ or 1^- mm ϕ.

3. (a)Deduce relationship of Angle of Bite (α), Maximum reduction (Δh_{max}) and projected length of the arc (L_p) with Roll parameters? Why for hot rolling, large diameter rolls but for cold rolling small diameter rolls are used for rolling metals? Why hot working rolls are grooved but cold working rolls are mirror polished? What is Friction Hill?
(b)What are Roll Flattening and Roll Bending? How can those be tackled in rolling system? What is Sendzimir mills?

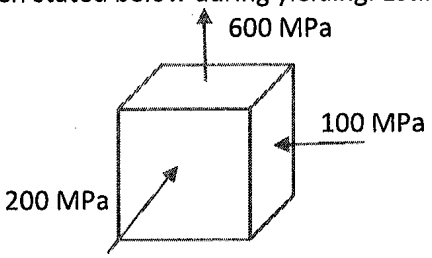
4. (a) Explain the mechanism of hot working with its advantages and its slow strain rate. How Flow stress can be predicted from Zenor-Hollomon equation? What is Strain rate sensitivity? How can Hot Working of ductile FCC metal give more difficulty in processing with respect to BCC metals? Why hot Tungsten filament drawing is easy? Why 60/40 brass hot extrude better than 70/30 brass in Gun shell manufacturing?
(b) How stacking fault energy play its role in cold working? Why Al foil making is easy? Why FCC Al is hot extruded normally but hardly cold drawn? Why FCC 18-8 stainless steel is difficult to both hot or cold rolling even having high plasticity? How semi-austenitic SS address the problem?

5. (a) What is Close Die Forging? Explain the importance of Flash? Comment also on design of flash land, flash thickness and gutter? Whether redundant work is more or less in comparison with open die forging? Draw and explain the nature of Forging load with Ram travel during Close die forging.
(b) Why forging is essential for making of shafts and hooks? Why Cast irons cannot be forged? What is Swaging? Differentiate between Upsetting and Drawing. Why Killed steels are used in forging but rimming steels are used in Rolling?

6. (a) Derive the Average pressure and load required to forge a slab in an open die in Exact as well as approximate solution. Show how friction hill develops in the contact surface. Without friction can forging be possible?
(b) Draw a Direct extrusion process with load – extension diagram showing variation of load with travel of plunger. What is Extrusion Ratio? What is Shaving? Draw the Wire drawing Dies labelling its sections. How drawing differs from extrusion? Find out theoretical wire drawing limit possible.

7. (a) A M.S bar of length l_o is uniformly hot drawn until its length is $3l_o$. Compute its true strain and its percentage engineering strain. A forger decided to compress the similar drawn bar to a true strain where the mod true strain would remain the same. What would the final compressed length of the M.S. bar?
(b)The plastic behaviour of an IF-steel has been expressed by $\sigma = 500.\epsilon^{0.50}$ MPa. Estimate the yield strength of a bar of this material if it is cold rolled to a reduction of area to 20%.
(c)In Vickers hardness test, a tester has taken P = 10 kg and d = 300μm respectively. Calculate VPN as well as approx. flow stress of the metal.
(d)The plane strain flow stress of a material is 300 MPa. A plate of 1.0 m wide and 2.5mm thick is to be cold rolled in a single pass to 2.0 mm using 30mm diameter rolls. Assume a coefficient of friction as 0.07.Compute the roll load for the operation.
(e)Consider extrusion of a round Al billet from 240cm to 6 cm. Estimate the extrusion load for an efficiency of 50% assuming flow stress to be 15 MPa. Also calculate energy per unit volume.

8. (a) Determine the Principal stresses for the state of stress $\begin{bmatrix} 0 & 0 & 300 \\ 0 & -400 & 0 \\ 300 & 0 & -800 \end{bmatrix}$. If the yield Strength of a steel is 950 MPa, find out whether yielding would occur in von Mises criterion.
(b)Find the shear stress required to nucleate a grain boundary crack in high temperature deformation that has been estimated to be, $\tau = \left(\frac{3\pi\gamma_b}{8(1-\nu)L}G\right)^{\frac{1}{2}}$; where,
$\gamma_b = Grain\ boundary\ Surface\ energy = 2\frac{J}{m^2}$
$L = Grain\ boundary\ Sliding\ distance, = 0.01\ mm$, G = 75 GPa, $\nu = Poisson\ ratio.$
(c) A system of stress has been stated below during yielding. Estimate the yield stress.



(d) A block of metal 200 mm long, 100 mm wide and 6.25 mm thick is being pressed between flat dies. If the uniaxial yield strength is $\sigma_o = 70MPa\ and\ \mu = 0.2$, determine the forging load in MT on the onset of flow and mean forging pressure during deformation. Assume von mises flow stress.
(e)Determine the maximum possible reduction as well as angle of bite for rolling a 300 mm thick slab with $\mu = 0.5$ and the roll diameter is 600mm. What is the minimum thickness possible if for a cold rolling mill having Roll of 100 mm ϕ , having rolled metal, σ_o =500 MPa, corrected Roll elastic modulus, E'=225 GPa, when $\mu = 0.15$, and Mill constant C=7.5? Given, $h_{Min} = \frac{C.\mu.R.\sigma_o}{E'}$ where R is the Roll Radius.

9. Write short notes on: (Any five) (i) Forming Limit Diagram, (ii) Lubrication in Metal working, (iii) Plastic strain ratio in Cold forming, (iv) Al – Extrusion (v) Cup Drawing, (vi) Spring back.