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M.E. PRODUCTION ENGINEERING, FIRST YEAR, SECOND SEMESTER EXAM 2025
ADVANCES IN METAL CUTTING AND FORMING PROCESSES

Time: Three hours
Full Marks 100

Answer any ***five*** questions
All parts of a question (a, b, etc.) should be answered in one place.

1. (a) What are the different methods of estimation of the working load in metal forming?
   (b) What are the advantages of slip line field theory over the stress evaluation method or slab method? What are the limitations of the slip line field theory?
   (c) Write down the flow rule and compare it with generalized Hook's law.
   (d) Derive the relationship between tensile and shear yield stress for ductile metal using both Von Mises' and Tresca's Yield Criteria.

   4+5+3+8

2. (a) Derive Hencky slip line equations.
   (b) Write down the upper and lower bound theorem and explain its physical significance.

   15+5

3. (a) Draw the Mohr circle and find out the principal stresses and slip lines at the (i) free surface, (ii) frictionless interface, (iii) interface with sliding friction, and (iv) perfectly rough interface
   (b)Fig.3(b) shows an upper bound field for 50% inverted plane strain extrusion. Draw the hodograph and determine p/2K.

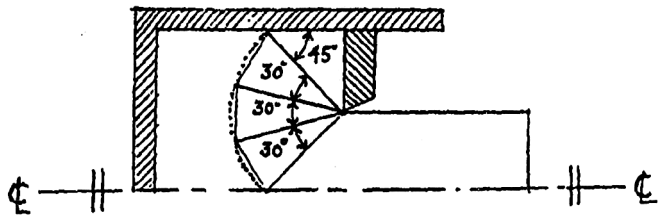

Fig.3(b)

10+10

4. (a)Using slip line field theory, show that in the case of single punch indentation of a semi-infinite block, the geometrical constraint on the flow increases the load required to cause yielding by a factor of 2.57, apart from any frictional contribution.
   (b) Draw the slip line field and hodograph for 50% inverted extrusion in plane strain with an unlubricated 180° die and determine the extrusion pressure.

[Turn over

10+10

5. (a) Estimate the upper bound load for frictionless single-punch indentation of a semi-infinite block.

(b) A mild steel plate is compressed rapidly between smooth parallel platens. Calculate the temperature jump across the lines of thermal discontinuity, assuming plane strain compression. The following data are given.
initial temperature of the mild steel = 680°C
density = 7.8 gm/cm3
specific heat = 620 J/kg/°C
yield stress = 350 MPa
width to thickness ratio = 1

12+8

6. (a) Discuss about the basic design features of drop forging dies using neat sketch of a typical drop forging die set.

(b) Explain why die and punch corners are provided with radius in deep drawing operation, where they are not provided in blanking/piercing operation. Also explain why angular clearance is provided on die in a simple blanking/piercing die and punch assembly. Show neat sketches of the die and punch shapes for both the operations.

10+10

7. (a) Show how stripping of the job from the punch can be achieved in deep drawing operation by machining a slight recess into the underside of the draw die using a neat sketch.

(b) Show the die and punch shapes for bending operations requiring more than one stage for
i) forming 'U' shape
ii) forming a bead

(c) Show how tubes and other hollow sections can be produced from sheet metals using a series of contoured rolls, where bending operation is performed continuously.

5+8+7

9. Show how the design of the die and punch assembly for sheet metal operations plays an extremely important role in reducing the operation time and cost. To illustrate your answer show neat sketches of :
(i) Progressive die and punch assembly
(ii) Compound die and punch assembly
for a particular component.

10+10