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M.E. PRODUCTION ENGINEERING
FIRST-YEAR, SECOND SEMESTER EXAM2024

ADVANCED MATERIAL FORMING, TOOL AND DIE DESIGN (PT)

Time: Three hours Full Marks 100

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

1 (a) What is meant by a statically admissible stress field?
(b) State the lower bound theorem and explain why the load predicted by the lower bound theorem is always lower than the actual working load.
(b) Estimate the lower bound bending moment required to cause plastic bending of a single notched bar.

3+5+12

2 (a) Derive Hencky slip line equations.
(b) Draw the slip line field and hodograph for 50% inverted extrusion in plane strain with an un-lubricated 180° die and determine extrusion pressure.

10+10

3 (a) Derive the relationship between tensile and shear yield stress.
(b) Explain redundant work in material forming operation.
(c) Write down the different methods of estimation of working load in plastic deformation.
(d) Draw the Mohr circle and find out the principal stresses and slip lines at the interface with Coulomb friction and a perfectly rough interface.

6+4+4+6

4 (a) Explain "heat lines" and temperature jumps during a fast metal forming process. Explain its impact on material properties in the plastic deformation process.
(b) Draw slip line fields for plane–strain indentation with flat, frictionless platens for various "thickness to width" ratios and draw a plot to show the variation of dimensionless indentation pressure with respect to "thickness to width ratio".
(c) Fig.4(c) shows an upper bound field for deep penetration of a 25 mm wide punch into a 150mm wide billet. Find the force necessary to pierce such a billet under sticking friction condition if σ_Y = 80N/mm^2. Assume plane strain deformation.

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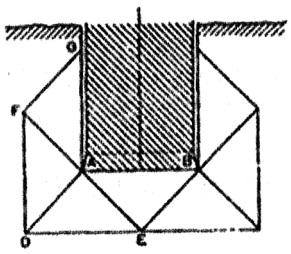

Fig. 4 (c)

4+6+10

5 (a) Draw a slip line field for piercing by a flat faced punch with suitable clearances at the sides and show the hodograph and determine the dimensionless indentation pressure p/2k.

(b) A series of 8 straight-sided parallel grooves 6 mm wide with 6mm separation is to be formed along a thick aluminum blank 100 mm wide and 300 mm long. If a suitable forging tool is used in a hydraulic press, what initial force would be necessary? How much would this increase by the time the punch had penetrated to a depth of 6 mm? Assume that the blank has previously been forged so that the yield stress is sensibly constant at 150 N/mm^2.

10+10

6 (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+(4+4)+7

7 (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

8 (a) 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) Compound die and punch assembly
(ii) Progressive die and punch assembly for a particular component.

10+10