BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)

CLASS: BTECH **SEMESTER : V**
BRANCH: PIE **SESSION : MO/2024**

SUBJECT: PE319 MATERIAL DEFORMATION PROCESSES

TIME: 3 Hours **FULL MARKS: 50**

INSTRUCTIONS:
1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
***4*. Before attempting the question paper, be sure that you have got the correct question paper.**
5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.

				CO	BL
Q.1(a)	I.	Classify metal working processes mentioning all the basis of classifications and its sub-categories.	[2+3]	CO1	BL2 BL4
	II.	'Ductile metals become stronger when they are deformed plastically at temperatures well below the melting point' – Illustrate the statement with proper reasoning and draw the relevant stress-strain curve with the percentage of cold work to demonstrate the phenomenon.			
Q.1(b)	I.	Explain the state of stress in the bending process. Name and draw schematic diagrams of three bending processes.	[3+2]	CO1	BL2 BL1
	II.	Differentiate between conventional extrusion and hydrostatic extrusion. Sketch a schematic diagram of the billet utilized for hydrostatic extrusion.			BL3
Q.2(a)	I.	Draw the shape of the yield surface for a two-dimensional state of stress satisfying the von-Mises criterion and label the elastic region, yield point and the failure region.	[3+2]	CO2	BL2 BL3 BL1
	II.	Derive that at the ultimate tensile strength of the flow curve, uniform strain is equal to the strain-hardening exponent.			
Q.2(b)	I.	Derive an expression for the average or mean flow stress.	[2+3]	CO2	BL2
	II.	The flow curve of an isotropic homogeneous ductile metal is described by Hollomon parabolic stress–strain relation with strength coefficient value of 550 MPa and strain-hardening exponent value of 0.22. During a forming operation, the final true strain that the metal experiences is 0.85. Determine the flow stress at this strain and the average flow stress that the metal experienced during the operation.			BL3
Q.3(a)		In a ring-compression test, a specimen of 15 mm in height with outside diameter (OD) 45 mm and inside diameter (ID) 22.5 mm is reduced in height by 50%. In which of the following two cases the interface friction factor will be higher? Justify your answer mathematically considering identical reduction in height: (a) OD after deformation = 57 mm, (b) OD after deformation = 61 mm.	[5]	CO3	BL4
Q.3(b)		The differential equation for the compression of a circular disk under axisymmetric condition for the mixed case of sticking and slipping is $\frac{dp}{p} = -2\frac{\mu}{h}dr$ and the pressure distribution for the condition where Couloumb's friction is valid is given as $p_{CF} = \sigma_0 exp\left\{2\frac{\mu}{h}(a-r)\right\}$ whereas that for sticking friction is given as $p_{FF} = \sigma_0\left[1+\frac{2m(a-r)}{\sqrt{3}h}\right]$.	[3+2]	CO3	BL3
	I.	Determine the expression for transition radius for the case of intermediate sticking and slipping.			
	II.	Describe the friction hill for this intermediate case with a neat sketch.			

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Q.4(a)	Determine the total forging load of a plate under plain strain condition for the case of sticking friction. State the assumptions considered for the analysis clearly.	[3+2]	CO4	BL3 BL1
Q.4(b)	I. A plate of copper with an initial size of 20 mm x 50 mm x 200 mm is homogeneously forged between flat dies to final dimensions of 10 mm x 100 mm x 200 mm. The mean flow stress in plain strain condition is 104 MPa. Determine the total load required to complete the forging operation when the coefficient of friction is 0.5. II. Define neutral plane in rolling. Sketch the variation of the velocity of rolls (v_r), entry (v_1) and exit (v_2) velocity of the stock for the cases of (a) skidding, (b) not unaided rolling and (c) unaided rolling.	[2+3]	CO4	BL3 BL3
Q.5(a)	Derive an expression for the drawing stress of a cylindrical tube drawn through a conical die by plug drawing. State the assumptions clearly.	[4+1]	CO5	BL3
Q.5(b)	A copper tube with outside diameter of 30 mm and thickness of 2.5 mm is close pass drawn homogeneously using a conical fixed plug with a semi-angle of 3° through a conical die with a semi-angle of 15° to produce outside diameter of 27 mm and thickness of 2 mm. The plane strain flow stress of copper is 300 MPa. Assuming the coefficient of friction at the tube–die interface to be 0.06 and that at the tube–plug interface to be 0.09, determine the drawing load and power required at a drawing speed of 1.5 m/s, assuming 90% efficiency of the power unit.	[5]	CO5	BL3

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