INDIAN INSTITUTE OF TECHNOLOGY KHARAGPUR

TIME: 3HRS, FULL MARKS: 100, DEPT.: MECHANICAL ENGINEERING

END SEMESTEREXAMINATION:Nov-2016

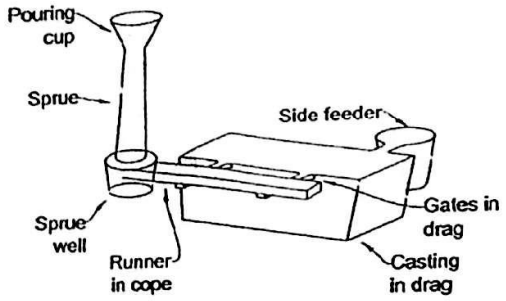
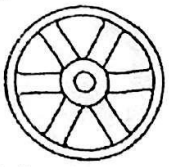
No of students: 181

SUB NO: ME31007, SUB NAME: CASTING, FORMING AND WELDING

Instructions:

- **Assume any data, if required BUT NOT mentioned in the question. Clearly mention your assumption.**

Part A (Casting, 33 marks)

C1	Answer ***any four*** briefly with neat sketch but within maximum **five** sentences.	
(a)	An engineer propose to integrate both riser and gating system with sand mould for casting rectangular component as shown in Fig. 1. What are the issues with this design? Please mention the possible defects developed in the casting.	3
	 Fig. 1 Riser and gating system selected for rectangular casting	
(b)	A casting engineer designed a pulley incorporating six thicker spokes and a thinner rim as shown in Fig. 2. It was decided to be fabricated through casting process route. Will there be any issue? If so, then propose a better deign (show schematically)?	3
	 Fig. 2 Pulley design to be cast	
c)	What are the advantages of using eutectic alloys for shape casting process? Explain at least four.	3
d)	What do you mean by investing and stuccoing (show with schematic diagram)? What is the effect of preheat temperature in investment casting process?	3
e)	Show schematically the semi-centrifugal casting process used for manufacturing of a rail wheel. What are the advantages of this process?	3
2 (a)	What is the process sequence of high pressure hot chamber die casting process? What are the process parameters affecting the quality of the component fabricated by this process?	3+2
(b)	The maximum equilibrium solubility of hydrogen at a partial pressure of 1 atm in liquid magnesium is 26cm^3 per 100 g. This drops to 18 cm^3 per 100 g upon solidification. The density of Mg (liquid and solid) is 1.74 g/cm^3. (i) What would be the gas porosity (volume of H_2/total volume) of the Mg casting if liquid saturated with hydrogen at 1 atm were allowed to solidify? (ii) What partial pressure of hydrogen should be maintained over the melt if a pore free casting is required?	3+2
3	Design a cylindrical riser with a height equal to twice its diameter that will compensate for shrinkage in a 2 cm X 8 cm X 16 cm casting. Note that (i) the riser should take 25 % larger time to solidify than casting,	5

	and (ii) the feeder efficiency is 15% and the shrinkage coefficient is 2%. (Note: use the solidification time as per Chorinov's rule: $t = K\left(\frac{V}{A}\right)^2$)	
(b)	You work in a cast house of a steel company where you intend to start uphill casting of steel using the bottom gating system as depicted in Fig. 3. The head of production asked you to estimate the filling time of the mould of 50 cm X 25 cm X 15 cm. Determine the filling time if the cross sectional area of the ingate is 5 cm².	6

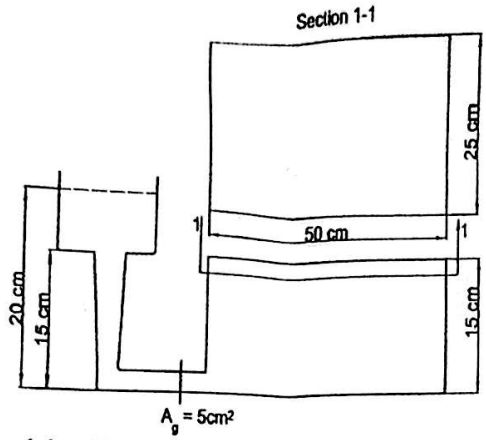
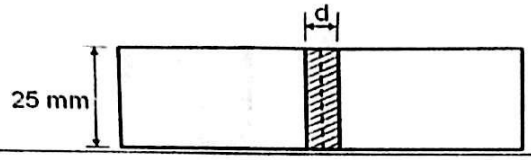


Fig.3 Bottom gating system used for filling the mould cavity of 15 cm height with uniform rectangular cross section of 50 cm X 25 cm.

	PartB(Forming, 34 marks)	
1. a)	A circular disc forging is being done by using two flat platens. There is a stick-slip frictional situation between platen and the blank. Derive the location of the point where the change of frictional condition does take place.	7
b)	An aluminum disc of 80 mm diameter and 32 mm thickness Is compressed to 8 mm thickness. The coefficient of friction, μ=0.2, and the yield strength in compression=100 N/mm². Find out the radius at which the sticking starts.	5
2. a)	Derive the force requirement in drawing a seamless tube through ***tube sinking*** process, by using a conical die. There is ***no change*** of thickness during the process. There is no ***land*** on the die. ***Back tension*** is applied, however ***no shear deformation*** is there at the entry and at the exit.	7
b)	A small hollow steel member having circular cross section of 30 mm outer diameter and 5 mm thickness is drawn to a circular cross section hollow member of 15 mm outer diameter. There is no change of thickness. This is done through a conical die of semi-die angle of 5⁰. The coefficient of friction between the die and the workpiece, μ=0.15. The yield strength is 320 N/mm². There is no change of yield strength during the process. Determine the drawing stress without the back tension.	5
3. a)	A sheet of 30 mm thickness is rolled to 20 mm thickness by 650 mm diameter rolls rotating at 120 rpm. Calculate the roll strip contact length.	5
4. a)	Write short notes on: Hydrostatic stress	3
b)	Martensite transformation	2

Part C (Welding, 33 marks)

W1	Discuss, with neat sketches, how material "continuity" is attained at a microstructural level in (a) Solid state welding (b) Fusion Welding	4+4
W2	Explain the possible reasons for (a) angular distortion and (b) Longitudinal distortion in Butt welds. Discuss the remedies, if any.	4+4
W3	In the context of an arc welding process, define the following terms and its influence on the weld quality. (a) Arc blow (b) Electromagnetic pinch effect (c) Explosive evaporation (d) Repelled transfer	2*4
W4	A carbon dioxide laser with a power output of 1 kW operates in the continuous wave mode. (For CO_2 laser, wavelength = 10 micron = 0.01 mm). Focal length and diameter of the lens used is 100 mm and 8 mm respectively. The diameter of laser beam is 6 mm. Find the spot size d. The laser-beam welding operation will join two pieces of steel plate together as shown (cross- section) in figure. The plates are 25 mm thick. The unit melting energy is 10 J/mm^3. The heat transfer factor (efficiency) is 0.70 and the melting factor (efficiency) is 0.55. Find the velocity of the laser beam movement (welding travel speed) if the beam penetrates the full thickness of the plates. Assume any unknown, if necessary. 	9