INDIAN INSTITUTE OF TECHNOLOY, KHARAGPUR

TIME: 3 HOURS, FULL MARKS: 100, No of Students: 130

Autumn End Semester: November 2010, Dept: MECHANICAL ENGG, **Sub No: ME31007**

3rd Yr BTech (H), **Sub Name: Casting Forming Welding**

Instruction: USE 3 DIFFERENT ANSWER SHEETS FOR 3 PARTS

N.B: Assume any data which is required, but not mentioned. Clearly mention in answer script.

PART A: Casting [33 Marks]

C1. (a) A ladle with a circular cross-section (diameter 2.0 m) contains $70X10^3$ kg molten steel. The steel is teemed through a circular hole in the bottom of ladle. The diameter of the hole is 3.0 cm. Calculate the time required to empty the ladle. (Density of steel is $7.8X10^3$ kg/m3)

(b) During solidification, a 50 wt% Pb–50 wt% Mg alloy is slowly cooled from 700°C to 400°C (See figure 1)

(i) At what temperature does the first solid phase form?
(ii) What is the composition of this solid phase?
(iii) At what temperature does the liquid solidify?
(iv) What is the composition of this last remaining liquid phase?

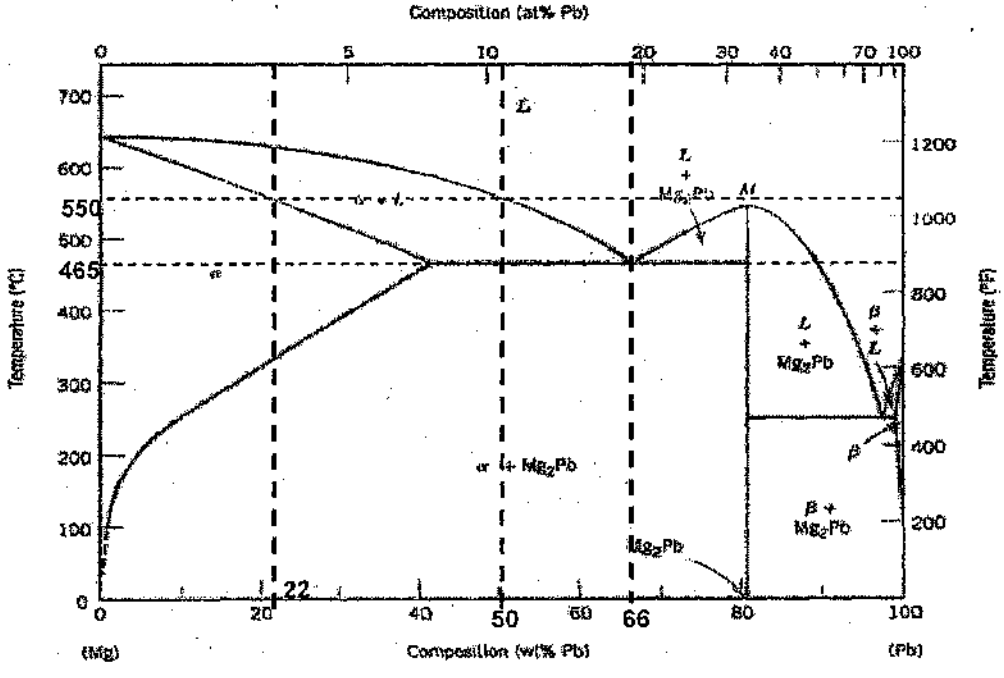
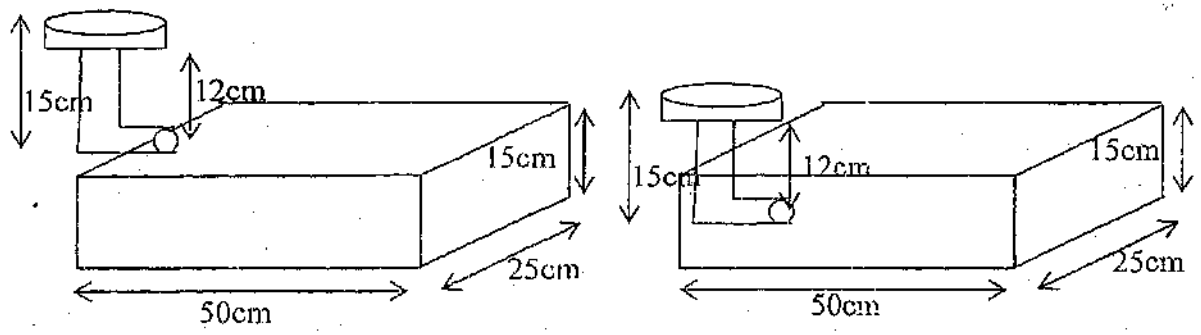


Fig. 1 Phase diagram of Mg-Pb binary alloy

(c) A spherical casting of diameter 10 cm has a cylindrical riser 5 cm in diameter and 10 cm high. Will the riser prevent macroporosity?

[6+2+3]

C2. (a) What do you mean by fluidity of liquid metal? What are the various factors which influence this?
(b) Two gating designs (top gating and bottom gating) for a mold of 50cmX25cmX15cm are shown in figure 2. The cross sectional area of the gate is 5 cm^2. Determine the filling time for both the designs.



(i)Top gating (ii)Bottom gating

Fig. 2 Schematic diagram of gating system for a sand mold (i) top and (ii) bottom.

(c) Why do hot tears appear in the casting?

[3+6+2]

C3. (a) Determine the size and location of the riser for the following castings.

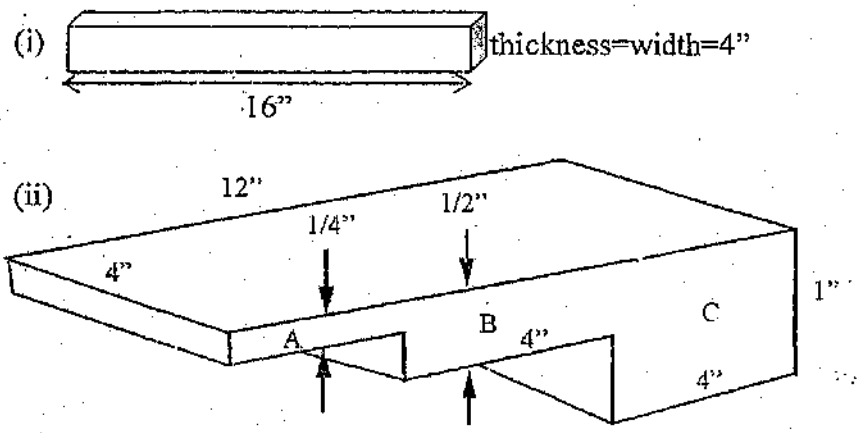


Fig. 3 Components with dimensions in inches (i) bar and (ii) stepped component

(b) An open tundish filled with molten steel has an upper area of 1.0 m X 0.30 m and a height of 0.60 m. The temperature of the melt is 1500^0C. At this temperature the density of the melt is $7.8X10^3$ kg/m^3. Its thermal capacity equals 830 J/kg K. The melt stays in the tundish for 10 minutes. Calculate the rate of heat loss by radiation (part of total rate of heat loss) from tundish if the temperature of the surroundings is 20^0C, and the emissivity of molten metal is 0.28. Calculate the temperature decrease of the melt caused by the heat loss due to radiation during its stay in the tundish.

Stefan – Boltzmann constant, $\sigma_B = 5.67 * 10^{-8}$ $W/m^2.K^4$ **[6+5]**

PART B: Forming [34 Marks]

F1. (a) Derive the force requirement for an open die forging process of a circular disc. Consider the stic slip frictional condition. [

(b) A circular disc of lead of radius 150 mm and thickness 50 mm is reduced to a thickness of 25 mm open die forging. If the coefficient of friction between the job and the die is 0.25, determine t maximum forging force. The average shear yield stress of lead can be taken as 4 N/mm^2. [

F2. (a) Derive the force requirement in a high friction forward extrusion process with semi-die angle 45^0. [

(b) Estimate the maximum force required for extruding a cylindrical aluminium billet of 50 mm diamet and 75 mm length to a final diameter of 10 mm. The average tensile yield stress and shear yield stress f aluminium are 170 N/mm^2, and 98 N/mm^2, respectively. Assume, semi-die angle is 45^0, and coefficie of friction is 0.15. [4

F3. Write short notes on: **[3+4+2**

(a) Electromagnetic forming
(b) Compaction procedures in powder metallurgy
(c) Plane-strain deformation

PART C: Welding [33 Marks]

W1. Write short notes on: **[5x2]**

(a) Metal transfer in GMAW process
(b) Typical arc welding defects
(c) Advantages of solid state welding
(d) Contact tube in GMAW process
(e) Flux core welding

W2. Answer the following: **[3x5]**

(a) Distinguish between friction welding and friction stir welding.
(b) With neat sketches illustrate two typical joints may be made by friction welding.
(c) Name two high energy density welding processes and explain how the high density is obtained.

W3. (a) Arc welding of structural steel produces un-acceptable distortions. What are the common methods that may be followed to reduce such problems? **[4]**

(b) Peening is carried out after manual metal arc welding. Why it is done so? **[4]**

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