INDIAN INSTITUTE OF TECHNOLOY, KHARAGPUR

TIME: 3 HOURS, FULL MARKS: 100, **No of Students: 172**

Autumn End Semester: November 2012, Dept: MECHANICAL ENGG, **Sub No: ME31007**

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

N.B: Assume any data which is required, but not mentioned and clearly mention the assumed data in the answer script.

PART A: Casting [33 Marks]

C1. (a) A parting gate is designed to fabricate a steel cast product of *50cmx25cmx15cm,* as shown in ***Fig.1.***

The parting surface is intersecting the mold at the half thickness. The cross sectional area of the ingate is *5* cm^2. Determine the mold filling time for the design.

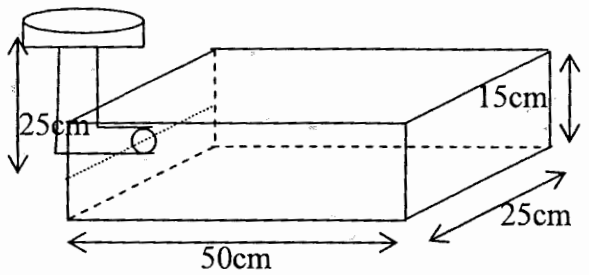

Fig. 1 *Schematic diagram of parting gate for a sand mold casting*

(b) What will be time required to solidify 100^0 *C* superheated molten steel in the above mold cavity? The data given for sand mold material and cast steel are given below:

sand mold material- density: $1.6 g/cm^3$, specific heat: $1.117\times10^3 J/kg.^0C$, thermal conductivity: $1.5 W/m.^0C$, and *steel metal-* density: $7.015 g/cm^3$, specific heat: $795 J/kg.^0C$ and melting point: 1540 ^0C. The ambient temperature: 30 ^0C. **[6+5]**

C2. (a) What do you mean by fluidity of liquid metal? What are the various factors which influence this?

(b) How many top risers will be needed in sand casting a bar of dimensions 4inches×4inches×120inches (thickness×width×length)? Why not a single top riser is effective for the above casting?

[5+6]

C3. (a) What are the attributes for an ideal gating system?

(b) The Caine's formula for two different castings obtained from laboratory based experimental results are $X = \frac{0.1}{Y-0.03} + 1.0$ and $X = \frac{0.1}{Y-0.03} + 0.08$. Answer the followings:

(i) What do X and Y represent?

(ii) Do you believe that both the equations belong to same cast material?

(iii) One of the above equations represents castings using risers with insulating sleeves. Which equation representing the case of insulating riser?

(iv)What will be the improvement of casting yield by using insulting sleeve for a constant freezing ratio of 1.2?

[5+6]

PART B: Forming [33 Marks]

F1. (a) Derive the force requirement for an open die forging process of a circular disc considering only Coulomb's frictional condition between the disc and the die. **[8]**

(b) A circular disc of lead of radius 140 mm and thickness 40 mm is reduced to a thickness of 20 mm by an open die forging process. If the coefficient of friction between the job and the die is 0.20, determine the maximum forging force. The average shear yield stress of lead can be taken as 5 N/mm^2. **[5]**
[Hint: The maximum force would be at the end of the operation].

F2. (a) Differentiate between tube drawing processes with mandrel and with plug. **[5]**
(b) What are the possible defects of a wire-drawn product ? **[3]**

F3. Write short notes on: **[4+4+4]**
(a) Different steps involved in powder metallurgy
(b) Explosive forming
(c) Forward and backward extrusion processes

PART C: Welding [33 Marks]

W1.(a) Plot the variation of pressure and current in a typical resistance spot welding cycle. Discuss & show graphically, the possibility of enhancing the welding cycle by incorporating i) Preheating ii) Forging force
(b) Explain the significance of tool geometry in Friction Stir welding (FSW).
(c) To facilitate bottom up fabrication in nanotechnology, joining of nano-wires/ nano-rods is required. Discuss a method to weld or join nanowires/nanorods.
(d) Briefly explain the causes of angular distortion in Butt welds. Discuss the remedies if any.
(e) A 75 mm diameter tube through a 25 mm thick plate acting as a lever on a shaft. The tube is fillet welded to the plate on both sides (pl refer **Fig 2.**) What weld size is required if the throat stress is not to exceed 120 N/mm^2? **[5*3]**

W2. (a) Discuss various modes of metal transfer and the influencing parameters in a typical arc welding process
(b) 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 f 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 in **Fig 3.** 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.

(c) The introduction of hydrogen into construction steels during welding has major deleterious effects. In this context, discuss (i) Hydrogen embrittlement, (ii) Hydrogen porosity, and (iii) Hydrogen cracking

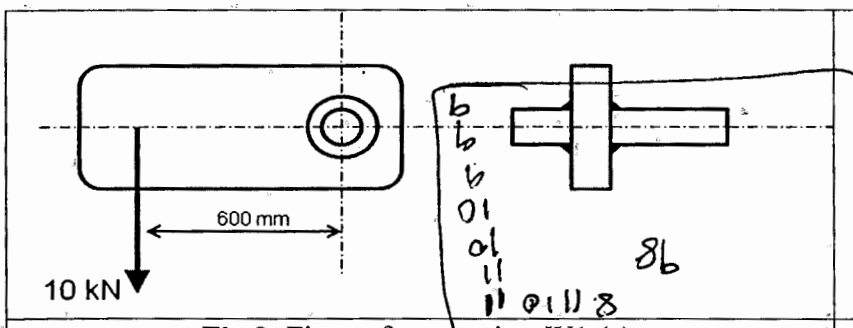

Fig 2: Figure for question W1 (e).

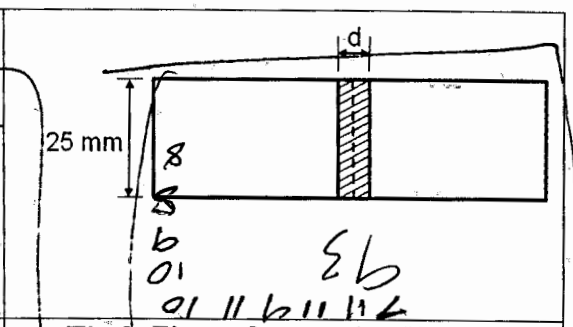

Fig 3: Figure for question W2 (b).

[3*6]

1 mark for good hand writing