INDIAN INSTITUTE OF TECHNOLOGY
END AUTUMN-SEMESTER EXAM, DEPARTMENT OF MECHANICAL ENGINEERING

SUBJECT NAME: CASTING-FORMING-WELDING, SUBJECT NO: ME30605

Time: 3 HOURS, FULL MARKS: 100, NO OF STUDENTS: 120 (3RD YR BTECH)

INSTRUCTIONS: 1. USE THREE (3) DIFFERENT ANSWER SCRIPTS FOR THREE (3) DIFFERENT PORTIONS (CASTING/FORMING/WELDING).

2. ASSUME ANY DATA IF IT IS REQUIRED AND IS NOT MENTIONED IN THE QUESTION PAPER.

CASTING [33 marks]

C1. (a) What is constitutional under cooling? How does it affect microstructure of cast metal? [4]

(b) A metal with melting temperature of 700^0 C is poured into the sand mold that is initially at 30^0 C. How thick must a mold be to be considered semi-infinite for times of 1 min and 15 min after pouring the metal? (Properties of sand mold given are: specific heat=1.16 J/g.^{0}C, thermal conductivity=0.6 W/m.^{0}C and density=1.5 g/cm^3). What is the error introduced by semi-infinite mold assumption for the above obtained thickness in both cases? [5]

(c) Fig. 1 shows two curves by Caine's formula. One is for mildly exothermic addition to top surface of riser. Which one of the two curves will represent the above case? [2]

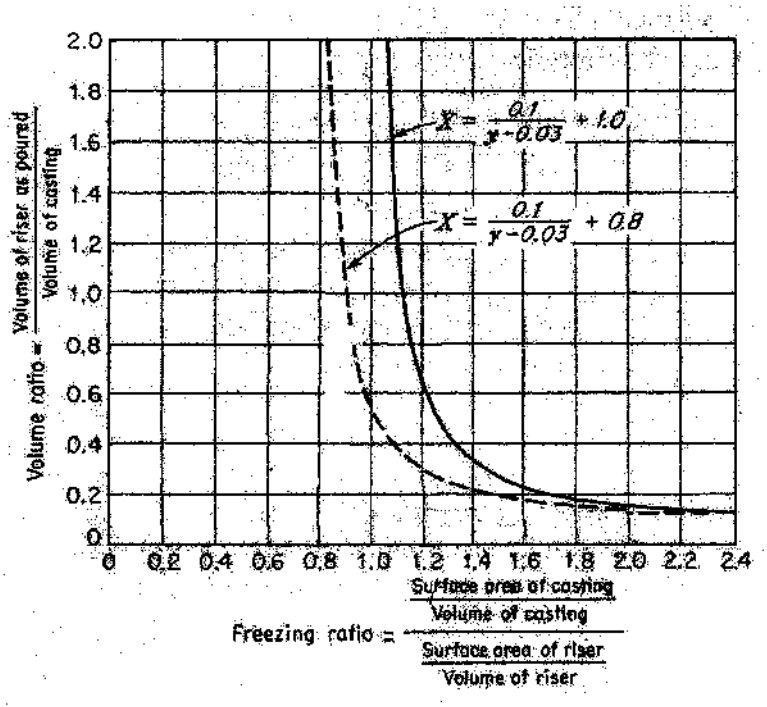

Fig. 1 Plot of freezing ratio-volume ratio for various conditions existing in riser.

C2. (a) The maximum equilibrium solubility of hydrogen at a partial pressure of 1 atm in liquid iron is 27 cm^3 per 100 gm. This drops to 7 cm^3 per 100 gm upon complete solidification. The density of iron (liquid and solid) is 7.9 gm/cm^3. Calculate the percentage of gas porosity in an iron casting if the partial pressure of hydrogen in contact with molten iron is 0.1 atm. What hydrogen partial pressure is required to eliminate the gas porosity? [5]

(b) What are the different design considerations in the gating system to avoid aspiration? [3]

(c) Show schematically use of skim bob, strainer core and splash core in the gating system. Why are they used in sand casting? [3]

C3. (a) How does the fluidity of Mg-alloy vary with pouring temperature? Interpret the results obtained (shown in Fig.2) from fluidity experiment on cast iron. [4]

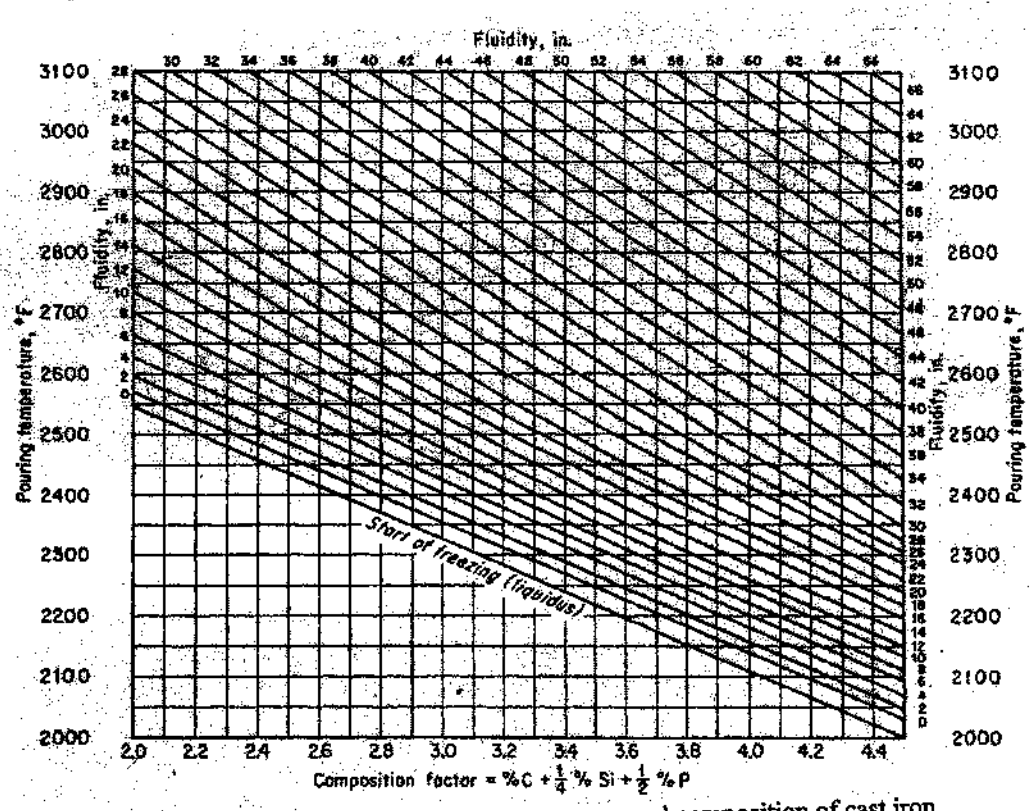

Fig. 2 Fluidity related to pouring temperature and composition of cast iron.

(b) How many top risers (diameter of riser is 5 inches) will be needed in sand casting a bar of dimensions 4inches×4inches×100inches (thickness×width×length)? Why not a single top riser is effective for the above casting? [3]

(c)Why die castings of Al-Cu alloy (with 4% copper) is advantageous in getting superior properties compared to sand casting? [4]

FORMING [34 marks]

F1. (a) Derive the expression for the drawing stress in a cylindrical rod drawing operation with a conical die. Tensile yield stress remains constant during the operation, and no back tension is applied. *[5]*

(b) Compare the force required to draw 25 mm x 6 mm copper strip to 45% reduction of area with that required for an equal reduction on round bar of the same cross-sectional area, using 12° included-angle dies, if coefficient of friction=0.07. Redundant work may be neglected. The average value of shear yield stress (k) is 0.15 kN/mm^2. Assume any other parameter if needed.

[5]

F2. (a) Determine the work load and frictional power loss from stress analysis, for a simple forward extrusion process, with a flat-face die in extruding a cylindrical billet.

[5+2=7]

(b) Estimate the maximum force required for extruding a cylindrical aluminium billet of 50 mm diameter and 75 mm length to a final diameter of 10 mm. The average tensile yield stress for aluminium is 170 N/mm^2. What percent of the total power input will be lost in friction at the start of the operation ? Coefficient of friction=0.15. Assume other parameters if needed. Consider the forward extrusion process.

[5]

F3. Write short notes on: *[4+4+4=12]*

(a) Various manufacturing steps of power metallurgy
(b) Tube piercing
(c) Shear spinning

WELDING [33 marks]

W1. Write short notes on [5x2]

(a) The use of coupling agent in ultrasonic testing
(b) Typical arc welding defects
(c) Solid state welding
(d) Spatter reduction
(e) Flux core welding

W2. Answer the following. [3x5]

(a) You are required to go for fusion welding of steel structures in cold ambient temperatures. List the technical difficulties you are likely to face and precautions you suggest?
(b) You are required to weld Aluminium to stainless steel. List the difficulties in this operation.
(c) Name two high energy density welding processes and explain how the high density is obtained.

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

(b) You are often advised to use low hydrogen electrodes. Why? [2x4]

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Best wishes from the course instructors

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