INDIAN INSTITUTE OF TECHNOLOY, KHARAGPUR

TIME: 2 HOURS, FULL MARKS: 100, **No of Students: 130**

Autumn Semester: September 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

PART A: Casting [33 Marks]

C.1 Derive Scheil equation, $C_s^* = k_0 C_0 (1 - f_s)^{k_0 - 1}$ for composition of solid at the advancing solid-liquid interface during solidification of casting.

Where, C_0 = nominal composition of alloy

C_s^* = composition of the solid at the solid-liquid interface

f_s = fraction of volume solidified

k_0 = equilibrium partition coefficient **[9]**

C.2 Derive an expression for a critical size (assuming to be a spherical) of new phase (embryo) to become stable and grow in terms of surface energy and volume free energy change during solidification. **[8]**

C.3 What is the effect of temperature gradient into the liquid metal (ahead of solid-liquid interface) on solidification growth morphologies for a pure metal. **[4]**

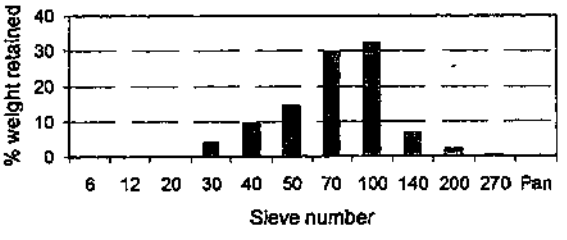
C.4 Why is a pipe appeared in a killed ingot casting? Which ingot casting is more prone to macro-segregation: (a) capped ingot (b) rimmed ingot? **[4]**

C.5 What are different pattern allowances? Which is a negative allowance? **[4]**

C.6 The AFS-GFN of two types of molding sands are 58 and 24 respectively, which molding sand will provide better surface finish in casting. Which among the above will result better permeability?

Sand distribution data obtained from sieve analysis is shown in Fig. 1. What is the screen number of this sand? **[4]**

Fig. 1 sand distribution



PART B: Forming [34 Marks]

N.B: Assume any data which is required, but not mentioned.

F1.(a). Draw the following crystal structures

(i) Body Centered Tetragonal (BCT), (ii) Face Centered Cubic (FCC), (iii) Hexagonal Close Packed (HCP)

(b). What would be effective number of atoms in a FCC crystal structure ? **[(1+1+1)+1=4]**

F2. (a) Draw the iron-carbon equilibrium phase diagram, showing peritectic, eutectic and eutectoid reactions.
(b) Draw a typical time-temperature-transformation (TTT) curve and show various zones of different phases.
(c) What are different case hardening processes ? Write briefly about them.
(d) What is a work hardening phenomenon ? Draw the true stress strain diagram for the following cases:
(i) Rigid and perfectly plastic, (ii) Elastic and perfectly plastic, (iii) Rigid and linearly work hardened, (iv) Elastic and linearly work hardened. **[5+3+2+2=12]**

F3. (a) Find out the location of the neutral point in a single stand strip rolling process considering no front and back tension.
(b) A 5 mm-thick aluminium alloy strip is rolled to a thickness of 4 mm, using steel rollers of radius 100 mm. The tensile yield stress of aluminium is 0.28 kN/mm^2. Determine (i) minimum coefficient of friction (μ_{min}) between the workpiece and the rolls for an unaided bite to be possible, (ii) the angle subtended at the contact zone of the roll centre, (iii) the location of the neutral point with $\mu = \mu_{min}$. No front and back tension applied. **[10+2+2+4=18]**

PART C: Welding [33 Marks]

W1. (a) Sketch a typical weld showing the relative shape and size of the fusion zones and heat affected zones for SMA welding process. (b) Why arc welding of Aluminium is most difficult? Can you suggest an appropriate process? **[12]**

W2. (a) Why hydrogen gas is detrimental during arc welding of steel though the gas can be safely stored in steel cylinders. (b) Explain how the electrode feed rate influences the arc voltage? **[12]**

W3. Sketch and name a few defects typical to arc weld process. **[9]**

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