Manufacturing Processes (TA201A)

Mid Semester Examination

Student Name _____ Roll No_____ Section No_____

Date: 20th September 2017 Maximum duration: 120 minutes

Question 1: State whether the following statements are true or false. **(40 marks)**

1. Steel mold casting comes under the category of expendable mold casting.

   True or **False**

2. Grains are usually of larger size using steel mold compared to sand casting.

   True or **False**

3. Thermoplastics can be heat treated several times without any change in molecular structure. **True** or False

4. Riser in sand casting should possess high volume to area ratio compared to other parts of the mold. **True** or False

5. Ni and its alloy typically melt at relatively low-temperature, and are used for making aircraft components. True or **False**

6. Chromium if added in large amount prevent steel from corrosion. **True** or False

7. The tendency for the formation of glass is high when the cooling rate of liquid melt is rapid. **True** or False

8. Titanium alloys with high stiffness and strength to weight ratio are used in making body implants. **True** or False

9. In cement concrete, steel rods provide the compressive strength to the concrete**.**

   True or **False**

10. Temperature at which liquid transforms to two distinct solids is called eutectic temperature. **True** or False

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11. Defects such as mold shift and core shift occur mainly in sand casting because of misalignment. **True** or False

12. Bakelite is formed by the reaction of phenol and formaldehyde. **True** or False

13. Glasses do not have a definite melting point but show anisotropic properties. True or **False**

14. In fibre reinforced polymer, epoxy matrix resist cracks and fracture. True or **False**

15. High carbon steel is used to making machinery cutting tools. **True** or False

16. Stainless steel is an alloy of iron, carbon and manganese. True or **False**

17. Ceramics possess metallic bonding. True or **False**

18. Natural rubber and teflon are examples of elastomers. True or **False**

19. The chemical formula of clay is $Al_2O_3.SiO_2.2H_2O$. True or **False**

20. α-ferrite phase possesses bcc structure and exists at room temperature. **True** or False

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Question 2: Figure 1 shows a tapered downsprue with the metal heads of H_1 in the pouring basin and the total metal head of H_2. If the cross-sectional areas of the downsprue at levels ***x*** and ***y*** are A_1 and A_2, respectively, determine the flow velocity of molten metal at both the levels, assuming molten metal is poured under gravity and the diameter of pouring basin is far greater than the diameter of downsprue. The losses due to friction can be neglected. Also, derive a relationship between heads H_1 and H_2 and cross-sectional areas A_1 and A_2 of the downsprue. **(5+5 marks)**

If the velocity at level ***x*** is given as 5 m/s and the cross-sectional area at ***x*** and ***y*** are 20 cm^2 and 10 cm^2, respectively, calculate the velocity at level ***y***. **(5 marks)**

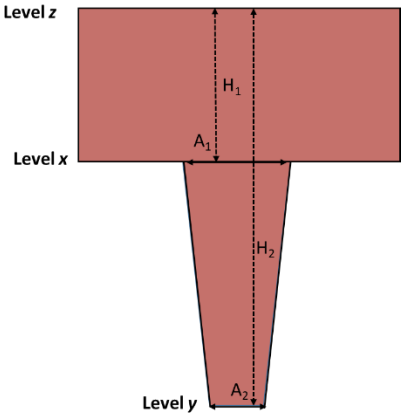

Figure 1. Tapered Down sprue

From Bernoulli's Theorem,

$$h + \frac{p}{\rho g} + \frac{v^2}{2g} = constant$$ (Assuming friction is absent)

Pressure term remains constant everywhere.

$$\frac{v_y^2}{2g} = \frac{v_x^2}{2g} + H_2 - H_1 = \frac{v_z^2}{2g} + H_2$$

Now value v_z is close to 0 as diameter of pouring basin is far greater than that of downsprue.

$$\frac{v_y^2}{2g} = \frac{v_x^2}{2g} + H_2 - H_1 = H_2$$

$$\Rightarrow v_y = \sqrt{2gH_2}$$

$$\Rightarrow v_x = \sqrt{2gH_1}$$

Now $A_1v_1 = A_2v_2$, therefore

$$A_2\sqrt{2gH_2} = A_1\sqrt{2gH_1}$$

$$\Rightarrow \frac{A_1}{A_2} = \sqrt{\frac{H_2}{H_1}}$$

Now v_x = 5 m/s; A_1 = 20 cm^2; A_2 = 10 cm^2

Therefore, $v_y = \frac{A_1V_x}{A_2} = \frac{20 \times 5}{10} = 10$ m/s

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Question 3. (1) State three differences between the amorphous and crystalline materials.

(5 marks)

S.No.	Crystalline Materials	Amorphous Materials
1	Materials in which atoms are situated in a periodic array over a large atomic distance	Non-crystalline solids lack a systematic and periodic arrangement of atoms over relatively large atomic distances.
2	They have a definite melting point	Do not have a sharp melting point
3	They exhibit anisotropic properties	They exhibit isotropic properties
4	Crystalline solids can be cleaved along definite planes	Amorphous solid undergo irregular breakage

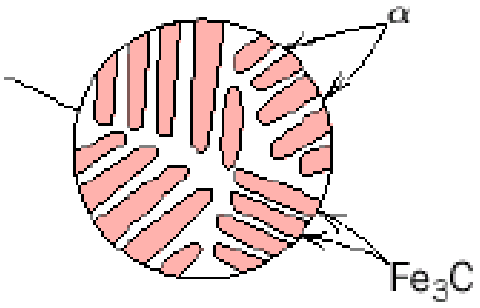
(2) Write the eutectoid reaction and draw the eutectoid steel microstructure (pearlite).

(10 marks)

Eutectoid reaction

$\gamma \rightarrow Fe_3C(s) + \alpha(s)$

Pearlite Steel



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Question 5. (1) In casting, state three possible reasons for the occurrence of cold-shut defect. **(5 marks)**

1. Low fluidity of molten metal
2. Pouring temperature is too low
3. Pouring is done too slow.
4. Cross-section of the mold is too thin

(2) Why the casting produced by using steel mold possesses a microstructure with smaller grain size compared to the casting made by sand mold? **(5 marks)**

Casting produced using steel mold possesses a microstructure with fine grain size because of the high cooling rate of the cast. Thus the cooling time is insufficient to cause noticeable grain growth. In the case of sand mold casting, thermal conductivity of sand mold is low which enables slow cooling of the cast. This allows sufficient time for the large grain formation in the sand mold casting.

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Question 4: In a sand-casting experiment performed using pure Ag, it took around 155 sec for a cube-shaped casting (with the edge of 50 mm) for the complete solidification.

a) Determine the value of the mold constant (C_m) in Chvorinov's rule. **(5 marks)**

b) If the same type of mold material is used, calculate the total solidification time for a cylindrical casting in which the radius r = 15 mm and length h = 50 mm. **(10 marks)**

a) Area of a cube = $6 \times (50)^2 = 15000\ mm^2$

Volume of a cube = $50 \times 50 \times 50 = 125,000\ mm^3$

$(V/A) = 125000 / 15000 = 8.333\ mm$

$C_m = T_{TS} / (V/A)^2 = \frac{155}{(8.333)^2} = 2.232\ s/mm^2$

b) Cylindrical casting with $r = 15mm$; $h = 50\ mm$

Area = $2\pi r^2 + 2\pi rh = 2\pi \times 15 \times 15 + 2\pi \times 15 \times 50$

$= 6126\ mm^2$

Volume = $\pi r^2 h = \pi \times 15 \times 15 \times 50 = 35343\ mm^3$

$V/A = 35343 / 6126 = 5.77$

$T_{TS} = 2.232 \times (5.77)^2 = 74.3s = 1.24\ min$