**Master of Engineering - Industrial Metallurgy, 1st year 2nd Semester Examination, 2019**

## Casting Technology

**Time: Three Hours** **Full Marks: 100**

**Answer Q. No. 1 and any five from the rest [16 each]**

**1. Explain / Answer as directed: (Any Twenty only) 1 x 20**

I. Express the condition $(\frac{G}{R})$ that produce Plane Front solidification for an alloy.

II. Why in Fe-C peritectic alloy transformation gets almost completed?

III. Name the phase that causes Gray Cast irons to be used as machine base.

IV. Why Na-bentonite is preferred over Ca-bentonite?

V. What is the Master pattern?

VI. How can the permeability of core sands be improved?

VII. Why too much importance is given on core binders over mold binders?

VIII. Why green sand molds are not generally used in modern automobile units?

IX. Increasing superheat will (a) increase (b) decrease Misrun in castings.

X. For brass castings Zinc flaring acts (a) beneficially (b) miserably.

XI. For the same weight, plate shape would solidify (a) faster (b) later, than spherical shape.

XII. What kind of allowance is needed for withdrawing pattern from sand mold?

XIII. Why Optimum moisture for any Bentonite percentage is fixed in any sand?

XIV. Why too much excess moisture in green sand molds cannot be tolerated?

XV. Why sea coal cannot be added in sand for steel castings?

XVI. Can you use talc and graphite in ferrous mold dressing?

XVII. What type of castings do you suggest for Sweep patterns?

XVIII. Why metal patterns are used in Shell molding?

XIX. Mold dilation may be due to anomalous contraction/expansion of grey cast irons at its liquid-to-solid state.

XX. Superheat can be very important/unimportant factor in casting of ductile irons.

XXI. High Si-content influences the eutectic temperatures for freezing of cast irons.

XXII. Why soaking steel ingots before forging/rolling takes so much long time to remove coring in the structure? Does Chemical potential play any role?

XXIII. LFR alloys produce better/worse properties than SFR alloys.

XXIV. Tin Bronze castings exhibit lower/higher solute content on the surface.

XXV. Why Rheocasting of Al-alloys develops higher mechanical properties?

2. Explain Laws of Gating Design. State the cause and deduce required aspiration correction in vertical and horizontal channels of liquid metal flow. Deduce the filling time for top and bottom gating in case of sand castings.
3. State Chvorinov rule for solidification of castings. Describe Modulus method of risering in sand castings. Why the optimum shape of risers is taken as cylinder? What is Directional solidification in casting? How it can be achieved during manufacturing castings?
4. State the minimum properties required for selection of moulding and core sands. Describe how those properties are measured in laboratory. What are Additives? Name two additives [**not named in question paper**] and state how those improve the sand moulding?
5. Deduce how critical radius and supercooling is related. How Constitutional Supercooling develops in alloy solidification? State the conditions of having different types of cast structures like Plane front/Cell/Dendrite/Random dendrite develop during alloy solidification.
6. Describe broadly Cast Iron family members drawing typical microstructures of each type. How Malleable and Ductile irons are produced? What is ADI and what is its speciality in application?
7. Discuss the basic assumptions in postulating Ruddle model of solidification for sand molds. Derive the solidification time in case of a Plate casting for Liquid Pure metal freezing in Sand Molds in terms of Dimensionless parameters.
   Calculate the thickness of the solidified shell in CONCAST upon emergence from chilled Cu-mold. Given Temperature of the liquid steel [1535$^{o}$C-Solidus point] upon pouring from 1560$^{o}$C. Length of the mold-700 mm, Rate of Withdrawal - 0.05 m/sec, Density of steel – 7600 kg/m$^3$, Specific Heat of Steel (liquid)- 780 J/kg/K, Heat of Solidification - 278 KJ/kg, Newtonian Heat Transfer Coefficient,$h_m = 1.7\,x\,10^3 - 16.2\,t_m$ *where* $t_m$ *is the Time of residence in M.*
   Temperature of Cooling water – 50$^{o}$C. Assume any data you may require.
8. Name any two important Alloy cast irons. Describe their microstructures, properties, uses and production methods.
9. (a) A steel pipe casting (B.P) measures 150mm O.D. and 100mm I.D with 1200mm in length. If casting is done horizontally with central axis parallel to the ground, calculate its pattern dimensions. Calculate its risers over the basis of pattern dimensions.
   (b) A Permeability tester clocked 20 sec for one testing when he identified the AFS sand sample actually measured 45mm height (H) and gauge pressure tested was found to be 9.0 gm.-wt. Calculate the percentage error in Permeability Number measurement.
   (c) During solidification, if the surface energy of Zinc is 60 erg/cm$^2$ and $\Delta H_v$ is 170 Cal/cm$^3$ with the estimated transformation temperature of 419$^{o}$C, calculate the minimum size of the nucleus in a metal mould *@ΔT=10$^{o}$C*. If a=2.66Å & c=4.94 Å, find out minimum number of unit cells the nucleus would hold.
10. Write short notes on: (i) Non-ferrous melting. (ii) NDT methods.

Or

Work out Methoding Design for Sand casting of a steel foundry for a plate with finish Dimensions, - 1100 mm x 800 mm x 30 mm.
[**Viscosity of Steel=** 6x10$^{-3}$ kg/m. sec, Liquid steel Density=7600 kg/m$^3$]