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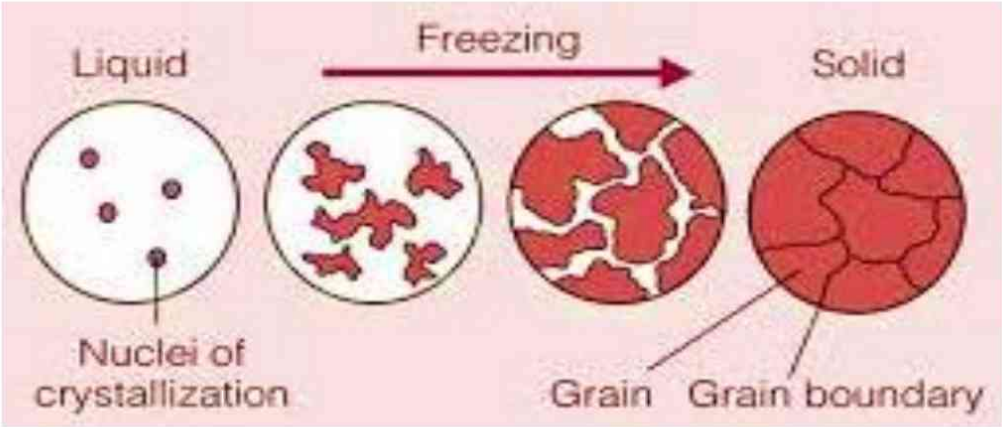
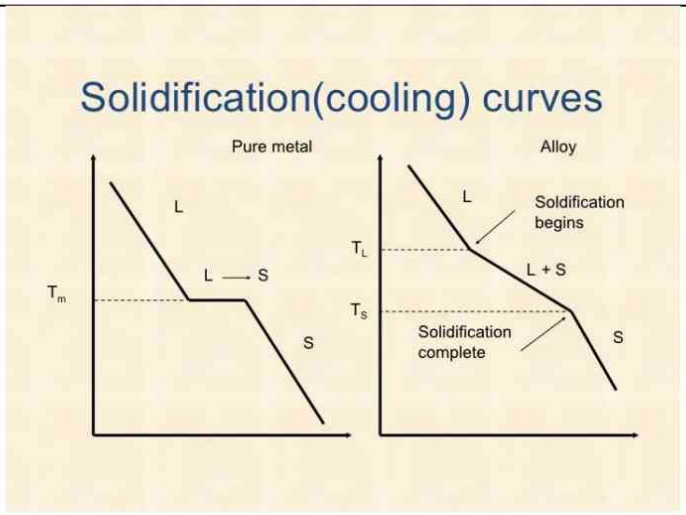
SCHOOL OF MECHANICAL ENGINEERING
CONTINUOUS ASSESSMENT TEST – I
WINTER SEMESTER 2023-2024

Reg. No.
(To be filled by the student)

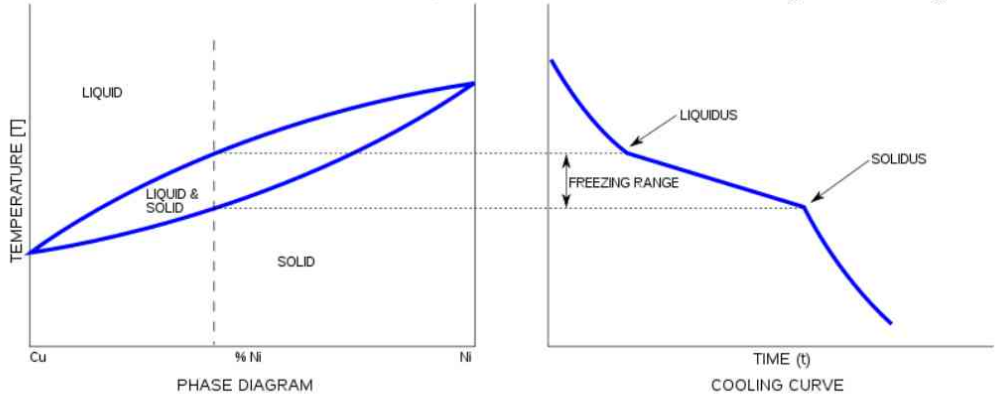
Programme Name & Branch : **B.Tech Mechanical Engineering**
Course Code : **BMEE302L**
Course Name : **Metal Casting and Welding**
Faculty Name(s) : **Dr. ARIVAZHAGAN N., Dr. SENTHIL KUMARAN S., Dr. NARENDRA KUMAR U., Dr. ANOJ GIRI, Dr. SREEKANTH M. S.**
Class Number(s) : **VL2023240504581/4586/4585/4576/6107**
Slot : **G2+TG2**
Date of the Exam : **17-February-2024**
Exam Duration : **90 minutes** **Maximum Marks: 50**

General instruction: Answer all questions

Q. No	Question	Marks
1.	Evaluate the various processes and parameters involved in the solidification of metal/alloy. Also draw the cooling curves for pure copper and copper-nickel alloy with 50 wt% nickel. Given the melting temperature of copper and nickel are 1085°C and 1453°C respectively.	10
Ans.	Elaborate the terminologies Nucleation: Homogeneous nucleation & Heterogeneous nucleation Growth: Planar growth & Dendritic growth Parameters: Critical radius (R*) and undercooling or supercooling (△T) on nucleation and growth process $r^* = \frac{2\sigma_{sl}T_m}{\Delta H_f \Delta T}$  Cooling Curved in Pure copper and Copper -Nickel alloy	

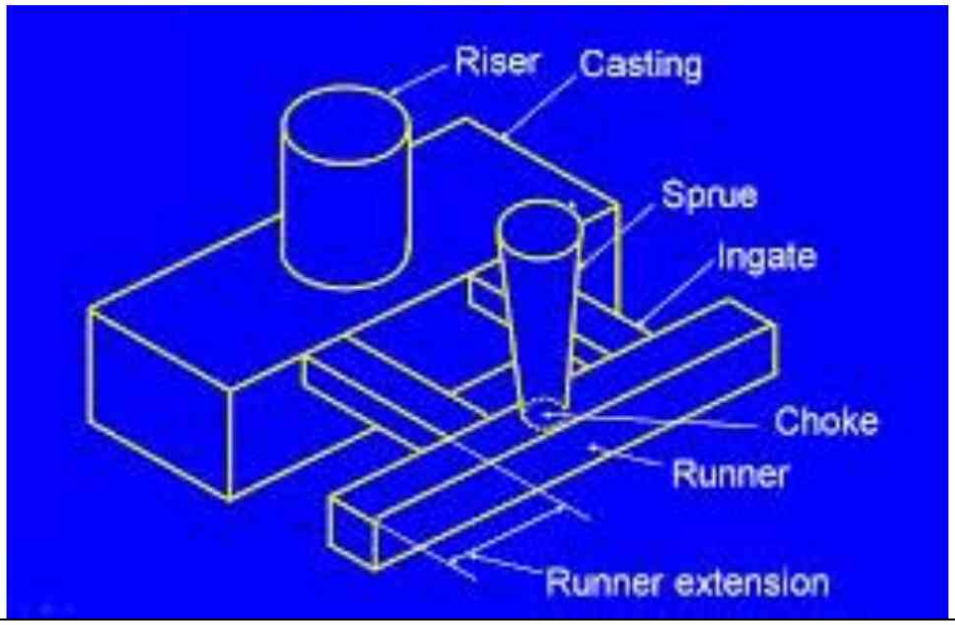


T_m= 1085°C and T_L and T_S need to take from phase diagram



2. Discuss the critical role of gating and risering system in designing a sound sand casting process with the help of schematic. Also discuss the significance of gating ratio in design of gating system. — 10

Ans.



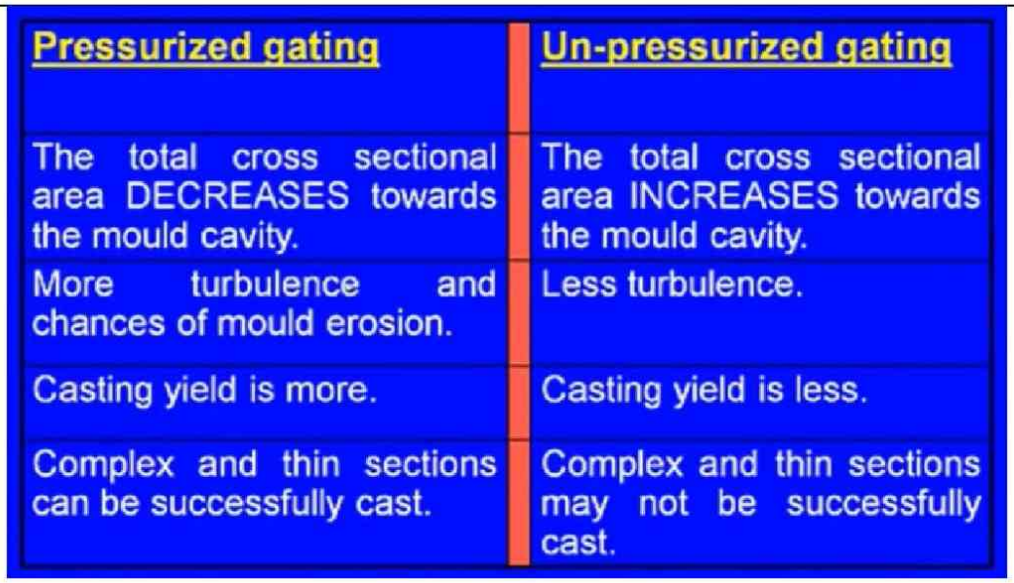
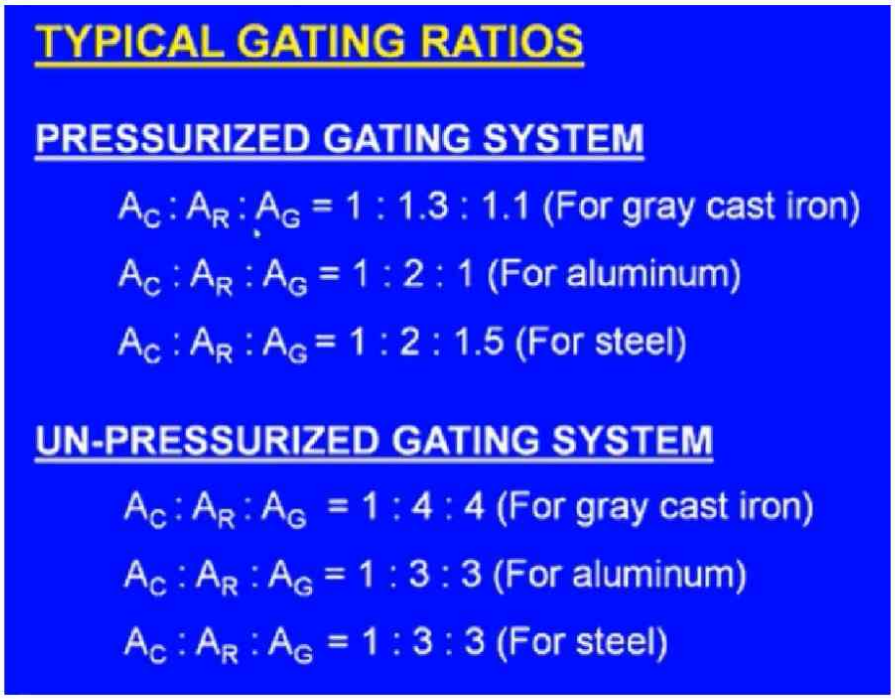
Function of Gating System

- To fill the mould cavity completely before freezing
- To minimise turbulence
- To avoid erosion
- To remove inclusions
- To regulate flow of molten metal
- To consume least metal – less scrap (Casting yield)
- To establish directional solidification

Function of Risering System

- Gating ratio= a:b:c where,
- a= cross-sectional area of sprue
- b= cross-sectional area of runner
- c= total cross-sectional area of ingates.
- Gating ratio reveals-
- whether the total cross- section decreases towards the mould cavity. This provides a choke effect which pressurizes the liquid metal in the system.
- Whether the total cross-sectional area increases so that the passages remain incompletely filled. It is an unpressurized system.

- The riser (feeder) must not solidify before the casting.
- The volume of riser(s) must be large enough to feed the entire shrinkage of the casting.
- The pressure head from the riser should enable complete cavity filling.
- Riser must be placed so that it enables Directional Solidification.

	 	
3.	In casting experiments performed using a certain ferrous alloy and type of sand mold, it took 185 sec for a cube-shaped casting to solidify. The cube was 35 mm on a side. I. Determine the value C_m of the mold constant in Chvorinov's Rule. [4 Marks] II. Determine the dimension of the *side riser* using modulus method for the preparation of cubic casting. [6 Marks]	10

Ans.	(a) $T = C\left(\frac{V}{A}\right)^n$ Where, T – Total solidification time V – Volume of the casting A – Surface area of the casting n = 2 C – Mould constant by experimental data Cube volume, a^3 and surface area = $6a^2$ $185 = C\ (42875/7350)^2$ **C = 5.44 s/mm** (b) According to Modulus Method Modulus/Solidification modulus = Volume/surface area Modulus of Riser = 1.2 Modulus of Casting = 1.2 x 5.83 = 7 For a side riser of cylindrical shape, H = D or 2R V/A of cylindrical riser (with H = 2R) = $\pi R^2H/(2\pi R^2+2\pi RH) = R/3 = 7$ mm R = 21 mm Riser Dimension Cylinder with H = 42 mm and R= 21 mm	
4.	Discuss the role of pattern design in sand casting process. The *cast iron* casting as shown in Figure 1 is to be made using a *wooden pattern*. Considering the data of shrinkage and machining allowance for *cast iron* from Table 1, calculate the dimension of the pattern. All Dimensions are in inches. You plan to consider the shrinkage and machining allowance from Table 1 and draft allowances of 1° for this casting. As a casting design engineer; you have to design all dimensions to reach the stage of a casting drawing for this part. a. Decide the shape and the dimension of the WOODEN-PATTERN to get the above casting, after considering allowances at each stage for the casting & present the sketch of that pattern. [6 Marks] b. For the pattern you had decided above, design the SAND-MOULD set up and show its *front view cross sectional sketch* clearly showing all the parts of the sand mould (for eg. showing cope flask, drag flask and other important components) in a ready-to-pour condition. [4 Marks]	10

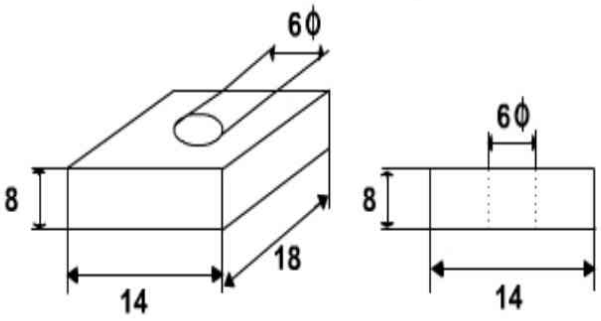


Figure 1

Table 1

Material	Dimension	Shrinkage allowance in inch	Machining allowance in inch
Cast Iron	Up to 24 inches 24 inches to 48 inches over 48 inches	0.125 0.105 0.083	0.15 0.20 0.25

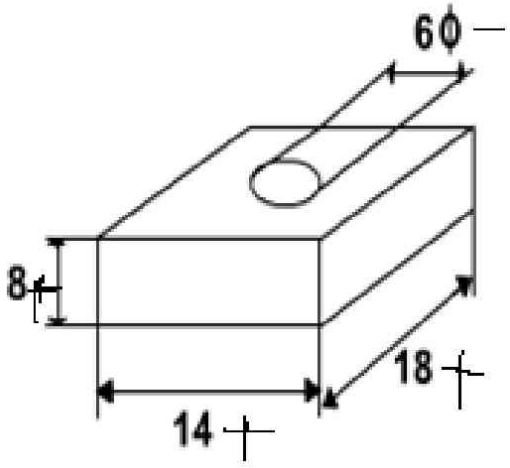
Ans.

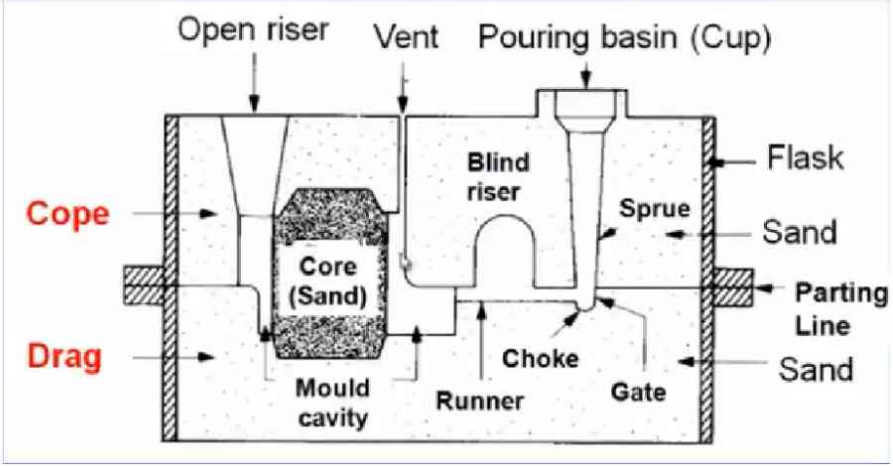
Machining allowance of all external surface M1 = L1 + 2 x 0.15 (on both sides)
Shrinkage allowance S1 = M1 + 0.125
Draft allowance give internal and external draft.
For bore surface M2 = 6 – 2 x 0.15
Shrinkage also S2 = M2 - 0.125
Draft add Shrinkage allowance S1 of bottom length

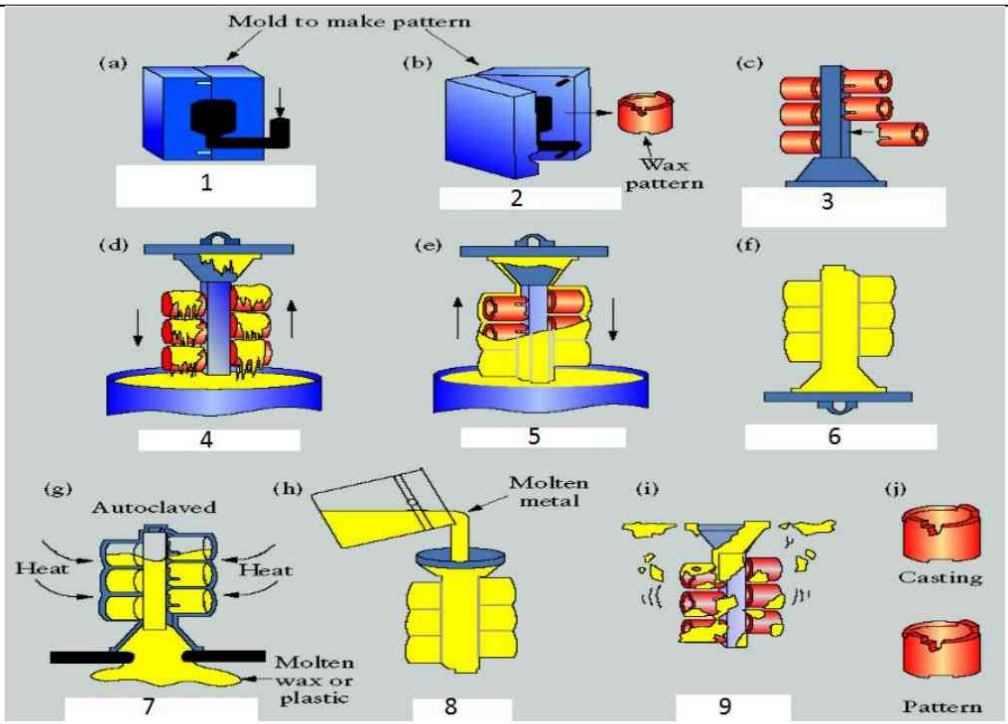
$$D1 = S1 + 2H \times \tan 1°$$

Draft need to added to bore bottom length also D2 = S2- 2H x tan 1°

Draw the pattern with given allowance



		
5.	Identity the casting technique used for the manufacturing of titanium single crystal for turbine blades. Discuss the sequence of operation with the help of schematic. Also discuss the benefits and draw backs of the process with respect to sand casting process.	10
Ans.	The casting technique for the manufacturing of titanium single crystal for turbine blades is **Investment Casting** • Investment casting is also referred to as ***lost-wax casting*** since the pattern is made of wax • The wax patterns are first dipped into a slurry of refractory material and subsequently, heated so that the wax melts away keeping a refractory mold • The mold is then further cured (sintering) to achieve proper strength. Very high melting temperature material can be cast in investment casting process because of the refractory mold • The molten metal is poured into the mold and is taken out after solidification by breaking the mold • Very high dimensional accuracy and surface finish can be achieved in investment casting process • However, the tooling cast is usually high and hence, investment casting process is primarily used for large size batch production or for specific requirements of complex shape or casting of very high melting temperature material	



Advantages

- Intricate forms having **undercuts** can be cast
- An **excellent details** and a **very smooth surface finish** on casting is obtained with **no disfiguring parting line** as found on castings made by cope and drag methods
- **Dimensional accuracy** is good
- Certain **unmachinable parts can be cast** to preplanned shape
- It may be used to **replace die casting** where **short runs** are involved

Disadvantages

- The process is **expensive** (tooling cost is high)
- It is **limited to small castings**
- It presents some **difficulties** where **cores** are involved