| Name:<br>Enrolment No: | UPES<br>UNIVERSITY WITH A PURPOSE |
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**UNIVERSITY OF PETROLEUM AND ENERGY STUDIES**
**Online End Semester Examination, December 2020**

**Course: Non-Ferrous Metals** **Semester: VII**
**Program: B. Tech Mechanical** **Time 03 hrs**
**Course Code: MEMA4002** **Max. Marks: 100**

**Instructions:** In Q7 and Q12, there is internal choice in the question.

**SECTION-A: Total 30 marks**
**Each question carries 5 marks**

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| Q 1 | Name any four strengthening mechanisms for metal/alloys.<br><br>a) _____, b) _____, c) _____, d) _____ | CO3 |
| Q 2 | True/False:<br><br>a) BCC crystal structure a closest packed structure. _____<br>b) FCC materials generally have lower strength and are more ductile as compared to BCC materials. _____<br>c) X-ray diffraction is used to identify the crystal structure of a material. _____ | CO1 |
| Q 3 | Select **ALL the correct options** related to phase transformations:<br><br>a) Diffusion is a thermally activated process.<br>b) Addition of Pb to Sn in large proportions will lead to phase separation.<br>c) Intermetallics have higher configurational entropy as compared to solid solutions.<br>d) Al has a very high tendency to dissolve in solid solutions of 3d transition metals.<br><br>Correct options are: _____ | CO3 |
| Q 4 | True/False:<br><br>a) Glasses are polycrystalline in nature. _____<br>b) Cu-Ni binary system forms a eutectic phase diagram. _____<br>c) Al is the most abundant metal in earth's crust. _____ | CO1 |
| Q 5 | Select **ALL the correct options** related to Aluminium:<br><br>a) Al forms a passive oxide layer.<br>b) Al alloys are not suitable for use in dry atmospheric environments.<br>c) Al alloys have a high strength-to-weight ratio. | CO3 |

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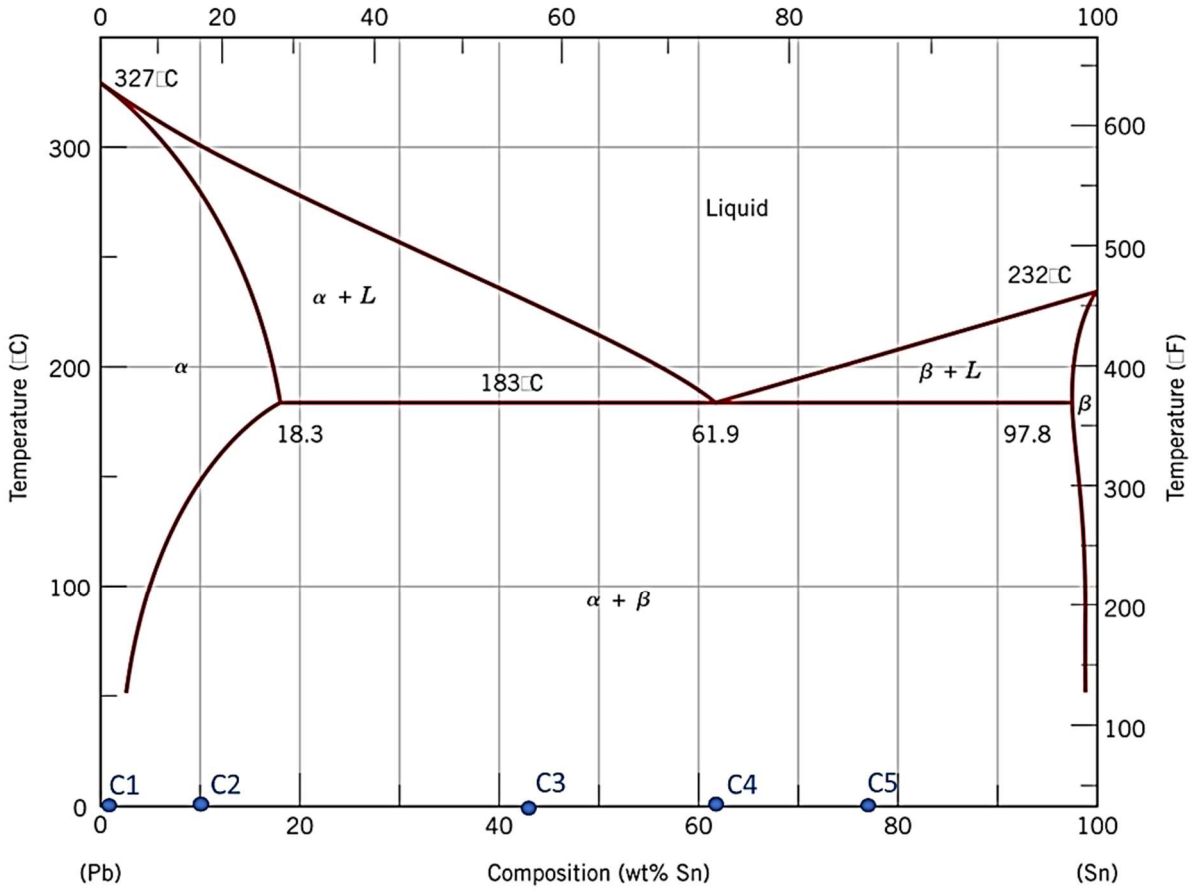
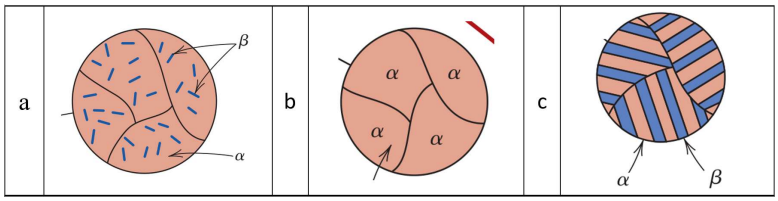
| Q 6 | Pb-Sn forms a eutectic phase diagram wherein α is Pb-rich and β is Sn-rich phase.<br>  <br><br>Below microstructures can correspond to different compositions: C1, C2, C3, C4 and C5 (marked in above phase diagram).<br>Identify the compositions to which each of the following microstructure belongs:<br>  <br><br>a) _____, b) _____, c) _____ | CO2 |
| | **SECTION-B : Total 50 marks**<br>**Each question carries 10 marks** | |
| Q 7 | a) What do you understand by the term 'high-entropy alloys'?<br>b) Briefly discuss **any two of the following** core-effects observed in these alloys:<br>• 'Severe Lattice Distortion Effect'<br>• 'Sluggish Diffusion Effect'<br>• 'Cocktail Effect' | CO3 |

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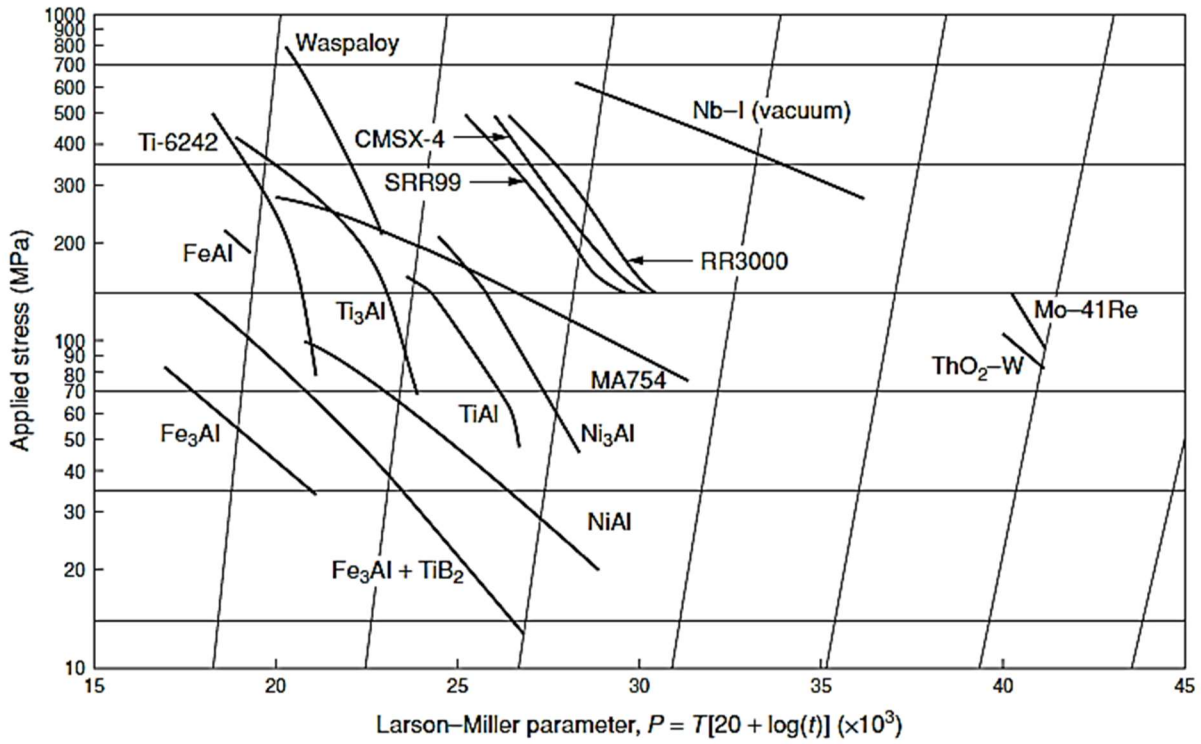
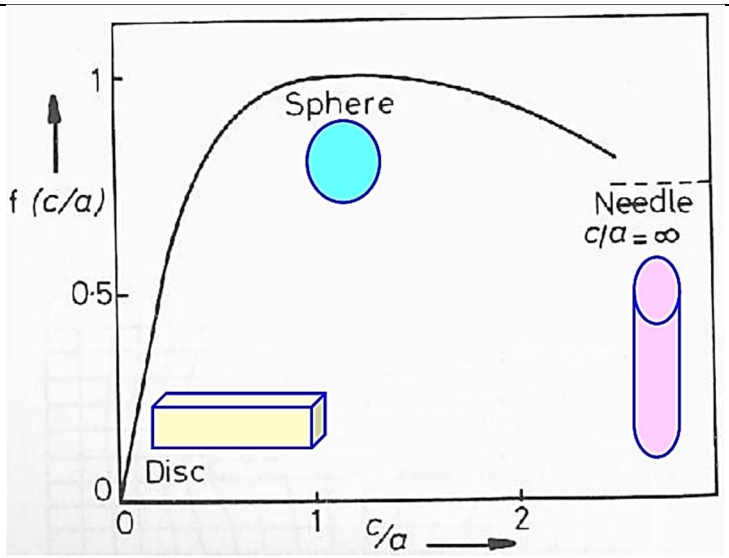
| Q 8 |  <br>The figure above shows the variation of Larson-Miller parameter of various materials at some specific temperature (T).<br>In the expression of LM parameter, '*t*' represents time to failure.<br>**Answer the following:**<br>a) Briefly discuss what does Larson Miller parameter indicate.<br>b) Using this graph, conclude which material will be most suitable for use at 300 MPa applied stress. | CO4 |
| Q 9 |  <br>Above figure shows the variation in lattice strain energy coefficient, f(c/a) as a function of the precipitate geometry (c/a ratio).<br>Based on this figure, **discuss why coherent precipitates generally have spherical shape whereas non-coherent precipitates have disc shape**. | CO3 |

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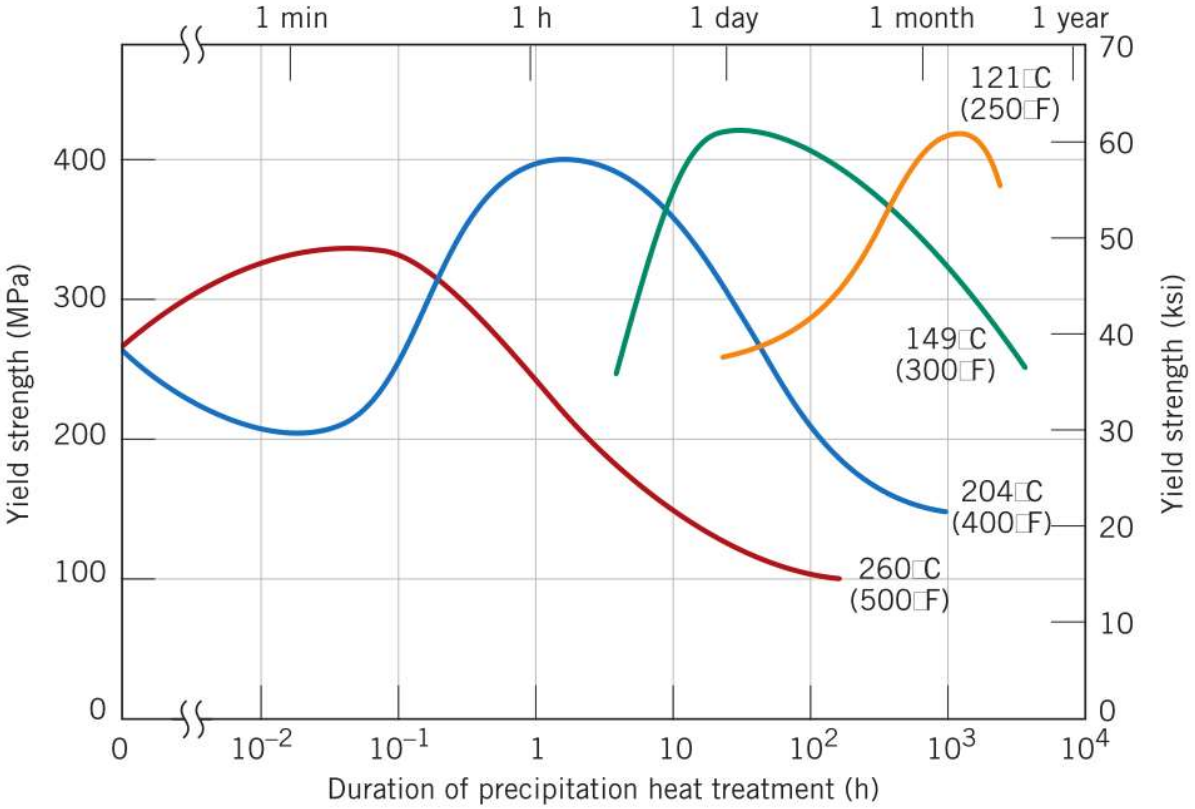
| Q 10 | a) What are superalloys?<br>b) Briefly discuss three reasons as to why 'Nickel' is the preferred base metal for making superalloys. | CO1 |
| Q 11 |  <br>Looking at the figure above which shows variation in strength as a function of ageing time and ageing temperature, **answer the following:**<br>a) At any ageing temperature, why is it that the strength first increases and then decreases with ageing time?<br>b) What optimum combination of ageing temperature and ageing time will you choose if you have to obtain the best strength? Briefly justify your choice. | CO3 |
| **SECTION-C: Total 20 marks** | | |
| Q 12 | **Answer any two of the following:**<br>a. Define creep. Draw a schematic creep curve to show various stages in the life of a material that undergoes creep failure.<br>b. The modern-day turbine blades are single crystal alloys. Discuss the advantages of using single crystal materials as compared to equiaxed or directionally solidified alloys.<br>c. Discuss the manufacturing process used for directional solidification of alloys. Also briefly discuss the use of 'seed' while creating single crystals.<br>d. Briefly describe the gamma (γ), gamma prime (γ') and gamma double prime (γ'') phases that are frequently observed in superalloys. | CO3 |