Name: Enrolment No:	

UPES

End Semester Examination, December 2023

Course: Aircraft Material **Semester:III**

Program: B. Tech Aerospace **Time : 03 hrs.**

Course Code: ASEG2013 **Max. Marks: 100**

Instructions:

1. **The Question paper has three sections: Section A, B and C.**
2. **Section B and C have internal choices.**
3. **Assume suitable data if needed**

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Explain the following: (i) Crystalline (single/poly) and amorphous materials (ii) Space lattice and Unit cells	4	CO1
2	Differentiate BCC, FCC and HCP crystal structures and give an example for each structure.	4	C02
3	Explain the difference between annealing and normalizing in heat treatment.	4	C01
4	Define consumable and non-consumable electrodes for arc welding.	4	C01
5	Discuss the manufacturing process for wing of an aircraft?	4	C02

SECTION B
(4Qx10M= 40 Marks)

6	Describe filament winding process for the production of fiber reinforced plastic (FRP) composites with neat sketch.	10	CO3
7	Propose the alloys useful for following aircraft component, 1. propeller blades 2. Propeller hubs 3. cowl ring. 4. Exhaust collector	10	C02
8	Explain the following machining operation in details with suitable example. 1) Turning operation 2) Milling operation 3) Boring operation 4) Broaching operation	10	C02

9	Describe the following mechanical properties of materials: a) Yield and Ultimate Tensile Strength (b) Engineering strain (c) Ductility, Resilience, d) Toughness and Hardness **OR** Explain the titanium alloys and their basic principle of heat treatment.	**10**	**C04**
SECTION-C (2Qx20M=40 Marks)			
10	Develop an in-depth comparative analysis outlining the unique properties of Inconel, Monel, and K-Monel alloys, and how each contributes to ensuring structural integrity, corrosion resistance, and high-temperature performance in aerospace vehicles	**20**	**CO3**
11	The space shuttle Challenger (STS-51) exploded just over one minute after take-off on 28 January 1986, killing seven astronauts. After an exhaustive investigation by NASA and other US agencies the cause of the accident was found. The space shuttle is fitted with two solid rocket boosters that generate an extraordinary amount of thrust during take-off that launches the main vehicle into space. Without the boosters the shuttle cannot generate enough thrust to overcome the gravitational pull of Earth. There is a booster rocket attached to each side of the external fuel tank, and each booster is 36 m long and 7.3 m in diameter (Fig.1). The boosters are constructed from hollow metal cylinders, with the joint connecting the cylinders containing two O-rings made with an elastomer. The elastomer is needed to create a tight seal to prevent hot gases escaping from the rocket motor during take-off. The Challenger accident was caused by several factors, with a critical problem being that one of the elastomer O-rings in a booster rocket did not form a tight seal owing to cold weather during take-off. Elastomers shrink and lose elasticity at low temperature and, at take-off, the O-ring was unable to expand sufficiently to form a seal between two cylinders. This caused hot combustion gases (over 5000 °F) inside the rocket motor to rapidly degrade the elastomer O-ring, thus allowing hundreds of tons of propellant to escape and ignite, thereby causing the space shuttle to explode (Fig. 2)	**20**	**C04**

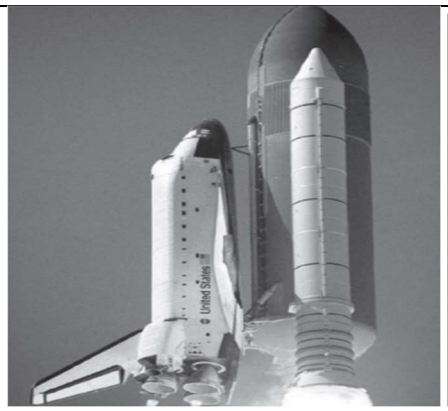


Fig-1 Rocket boosters on the space shuttle

Fig-2 Explosion of the space shuttle Challenger (STS-51).

Based on the above case study answer the followings.

1. Propose potential engineering solutions that could prevent the failure of elastomer O-rings in cold weather conditions during space shuttle launches. [05]
2. Conduct a detailed analysis of the consequences of the O-ring failure, considering the rapid degradation of elastomer and the escape of hot combustion gases. [05]
3. Devise a comprehensive checklist for ensuring the resilience and functionality of critical components in space shuttles, considering factors such as temperature variations and material properties. [10]

OR

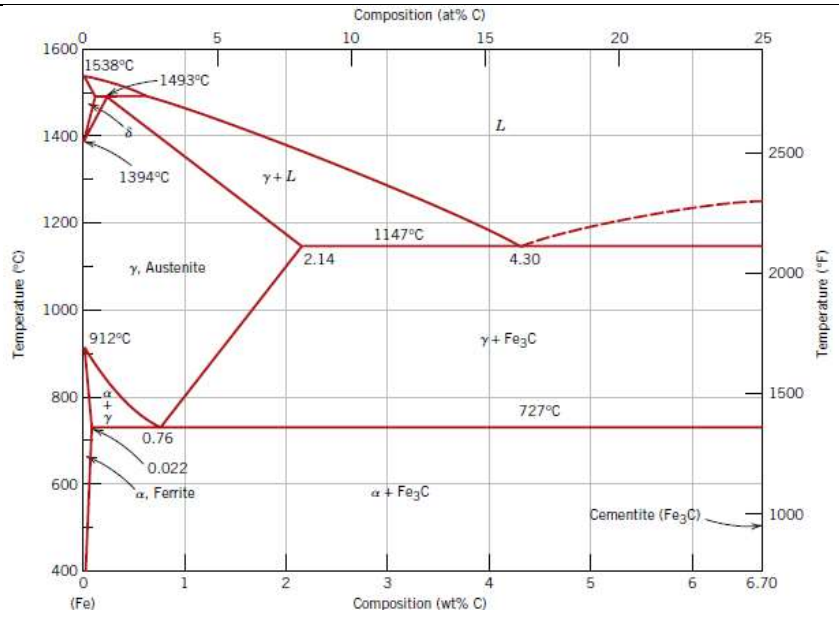
Analyze the Iron-Carbon phase diagram shown below and answer the following questions:

(i) Differentiate between different types of steels based on their carbon concentrations. Write the solubility of carbon in ferrite at 727°C.

(ii) Write eutectoid, eutectic and peritectic temperatures.

(iii) Write all the invariant reactions with their phase compositions.

(iv) Sketch and explain the microstructure evolution of eutectoid, hypo eutectoid and hypereutectoid steel.



Iron-carbon phase diagram