**R13**

**Time: 3 hours**                                                                 **Max. Marks: 75**

**Note:** This question paper contains two parts A and B.
Part A is compulsory which carries 25 marks. Answer all questions in Part A. Part B consists of 5 Units. Answer any one full question from each unit. Each question carries 10 marks and may have a, b, c as sub questions.

## PART - A

**(25 Marks)**

| | | |
|---|---|---|
| 1.a) | Distinguish between missile and space launch vehicle. | [2] |
| b) | Classify various Hypersonic transport vehicles. | [3] |
| c) | Explain the internal physics of an isolator in supersonic combustion. | [2] |
| d) | Describe various flow losses encountered in nozzle. | [3] |
| e) | Explain the characteristic features of liquid and solid propellants. | [2] |
| f) | Define the terms thrust coefficient and specific impulse. | [3] |
| g) | Explain Mono propellant and Bi-propellant with example combinations. | [2] |
| h) | Explain erosive burning and end burning of a solid rocket motor. | [3] |
| i) | What is the function of solar cell arrays in Propulsion system? | [2] |
| j) | Explain the problem of gravity loss. | [3] |

## PART - B

**(50 Marks)**

2.a) Explain the Reaction control system for space flight propulsion and its applications.
  b) Explain how the power is generated for an in-space spacecraft and how momentum thrust is produced.                                                          [5+5]

**OR**

3.a) With a neat sketches explain Low–level strike and Strategic Bombing mission profile for a jet aircraft.
  b) How is forward motion of an aircraft achieved by propeller action? How does the aircraft lift off the ground? Explain with the help of illustrative sketches.        [5+5]

4.a) Explain in detail the constructional features and working principle of Liquid Air Collection Engine (LACE).
  b) What is after burning in turbojet engines? Explain briefly with the aid of a diagram.                                                                    [5+5]

**OR**

5.a) Calculate the air flow rate through the engine, cross section area of the propelling nozzle exit, thrust, thrust power, propulsive efficiency of a turbojet engine from the following data:
Flight mach number = 0.85
Flight altitude = 12000 m
Cross sectional area of the inlet diffuser at entry = 0.5 $m^2$
Air/fuel ratio = 60
**Conditions at the exit of the exhaust jet:**
Pressure = 477 Mbar
Temperature = 1000 K
Velocity = 660 m/s
Calorific value of the fuel = 43 MJ/Kg
  b) Describe the working of a scramjet engine. What are its advantages over ramjet engine?                                                                    [6+4]

6.a) Describe the over expanded and under expanded nozzle for a rocket engine.

  b) A rocket nozzle has a throat area of $18$ cm$^2$ and combustion chamber pressure of 25 bars. If the specific impulse is 130 seconds and weight flow rate is 44.145 N/s. Determine:
  i) Thrust Coefficient
  ii) Propellant Weight Flow Coefficient
  iii) Specific Propellant Consumption and
  iv) Characteristic Velocity.                    [5+5]

**OR**

7.a) Describe the various factors considered for the design of a rocket.

  b) Consider a rocket engine where the combustion chamber pressure and temperature are 30 atm and 3756 K respectively. The area of the rocket nozzle exit is 15m2 and is designed so that the exit pressure exactly equals ambient pressure at a standard altitude of 25 km. For the gas mixture, assume $\gamma = 1.18$ and the molecular weight is 20. At a standard altitude of 25 km, calculate:
  i) Specific impulse,
  ii) Exit velocity,
  iii) Mass flow,
  iv) Thrust and
  v) Throat area.                    [5+5]

8.a) Explain the solid propellant grain design considerations and the features of various grain configurations.

  b) Explain briefly the following terms in solid propellant rockets:
  i) Linear Burning rate
  ii) Combustion rate
  iii) Propellant area ratio.                    [5+5]

**OR**

9.a) Write a short note on following related to liquid rocket engines:
  i) Steady state cooling methods
  ii) Transient cooling methods.

  b) Why does heat transfer increase during combustion instability in a liquid rocket engines?                    [5+5]

10.a) What do you understand by electrostatic thrusters? Explain the working principle and various types with the help of suitable diagrams.

  b) Compare the performances of chemical, Nuclear and electro dynamic rockets and discuss their application.                    [5+5]

**OR**

11.a) What do you understand by electro-thermal thrusters? Explain the working principle and various types with the help of suitable diagrams.

  b) Write a short note on microwave thermal propulsion system.                    [5+5]

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