B.E. (Aeronautical Engineering) Sixth Semester (C.B.S.)

Propulsion - II Paper - I

P. Pages : 3 **TKN/KS/16/7514**

Time : Three Hours * 0 3 6 7 * Max. Marks : 80

Notes :
1. All questions carry marks as indicated.
2. Solve Question 1 OR Questions No. 2.
3. Solve Question 3 OR Questions No. 4.
4. Solve Question 5 OR Questions No. 6.
5. Solve Question 7 OR Questions No. 8.
6. Solve Question 9 OR Questions No. 10.
7. Solve Question 11 OR Questions No. 12.
8. Due credit will be given to neatness and adequate dimensions.
9. Assume suitable data whenever necessary.
10. Diagrams and chemical equations should be given whenever necessary.
11. Illustrate your answers whenever necessary with the help of neat sketches.
12. Use of non programmable calculator is permitted.

1. a) Derive the ideal efficiency of ramjet engine? **7**

b) With the help of neat sketch explain the working with advantages and disadvantages of ramjet engine? **7**

OR

2. A ramjet engine operates at M = 1.5 at an altitude of 6500m. The diameter of the inlet diffuser at entry is 50 cm and the stagnation temperature at the nozzle entry is 1600k. The calorific value of the fuel used is 40MJ/kg. The properties of the combustion gases are same as those of air $(\gamma = 1.4, R = 287\,J/kg\cdot k)$. The velocity of air at the diffuser exit is negligible. **14**

Calculate:

a) The efficiency of the ideal cycle
b) Flight speed
c) Air flow rate
d) Diffuser pressure ratio
e) Fuel – air ratio
f) Nozzle pressure ratio
g) Nozzle jet Mach number
h) Propulsive efficiency
i) And thrust

Assume the following values: $\eta_D = 0.90,\ \eta_B = 0.98,\ \eta_j = 0.96,$ stagnation pressure loss in the combustion chamber $= 0.02 p_{02}$ z = 6500m the properties of air are

$T_1 = 245.90\,k,\ p_1 = 0.440,\ a_1 = 314.50\ m/sec, \rho_1 = 0.624\,kg/m^3$

3. a) How the combustion will take place in scramjet engine? **7**

b) What do you mean by integral ram rocket engine, explain? **7**

OR

4. a) Write a short note on Hypersonic propulsion? **4**

b) A rocket projectile has a following characteristics: **10**

Initial mass	200 kg
Mass after rocket operation	130 kg
Payload, non propulsive structure etc.	110 kg
Rocket operating duration	3.0 sec
Average specific impulse of propellant	240 sec

Determine the vehicle's mass ratio, Propellant mass fraction, propellant flow rate, thrust, thrust -to-weight ratio. acceleration of vehicle, effective exhaust velocity, total impulse and impulse – to weight ratio.

5. a) What is basic principle operation of rocket. Explain with the help of neat sketch? **7**

b) Explain the different types of nozzle in rocket with the help of diagram and working principle? **6**

OR

6. a) An ideal rocket chamber is to operate at sea level using propellants whose combustion product have a specific heat ratio k of 1.30. Determine the required chamber pressure and nozzle area ratio between throat and exit if the nozzle exit Mach number is 2.40. The nozzle inlet Mach number may be considered to be negligibly small. **7**

b) A rocket operates at sealevel $(p = 0.1013\,MPa)$ with a chamber pressure of $p_1 = 2.068\,MPa$,a chamber temperature of $T_1 = 2222\,k$ and a propellant consumption of m = 1 kg/sec (Let k = 1.30, R = 345.7 J/kg k). Calculate the ideal thrust and the ideal specific impulse. **6**

7. a) What are the selection criteria of solid propellants? **6**

b) Explain atleast two methods of holding the propellants grain in terms of solid propellants? **7**

OR

8. The following requirements are given for a solid propellant rocket motor: **13**

Sea level thrust	200 lbf average
Duration	10 sec
Chamber pressure	1000 psia
Operating temperature	Ambient (approx . $70^{\circ}f$)
Propellant	Ammonium nitrate – hydrocarbon

Determine the specific impulse, the throat and exit areas, the flow rate, the total propellant weight, the total impulse, the burning area and an estimated mass assuming moderately efficient design, Properties for this propellant are : k = 1.26, $T_1 = 2700^{\circ}f = 3160\,R$, $r = 0.10\,in/sec$ at 1000 Psia, $c^* = 4000\,ft/sec$, $\rho_b = 0.056\,lb/in^3$, molecular weight $= 22\,lbm/lb-mol.$ gas constant $= \frac{1544}{22} = 70.2\,ft-lbf/lbm-R.$

9. a) What are the advantages of liquid rocket over solid rocket engine? **6**

b) Explain the selection procedure of liquid propellant? **7**

OR

10. A liquid oxygen-liquid hydrogen rocket thrust chamber of 10000 lbf thrust operates at a chamber pressure of 1000 psia, a mixture ratio of 3.40, has exhaust products with a mean molecular mass of 8.9 l6 ml lb-mol, a combustion temperature of $4380^{\circ}f$ and a specific heat ratio of 1.26. Determine the nozzle area. Exit area for optimum operation at an attitude where $p_3 = p_2 = 1.58$ psia. the propellant weight and volume flow rates and the total propellant requirements for 2 minutes of operation. Assume that the actual specific impulse is 97% of the theoretical value. **13**

11. Determine the flight characteristics of an electrical propulsion rocket for raising a low satellite orbit. Data given, F = 0.20N, Duration = 4 weeks $= 2.42 \times 10^6$ sec, $I_s = 2000$ sec, Payload mass = 100kg, $\alpha = 100\,w/kg$, $\eta_t = 0.5$. **13**

OR

12. a) Explain with neat sketch the working of nuclear rocket? **6**

b) What are the preliminary concepts in nozzle less propulsion, explain? **7**

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