Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 91067

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2019

Fifth Semester

Aeronautical Engineering

AE 6504 – PROPULSION – II

(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Use of Bar Tables allowed

Answer ALL questions

PART – A (10×2=20 Marks)

1. How scramjet engine is differ from ramjet engine ?
2. Why hydrogen is the suitable fuel used for hypersonic propulsion ?
3. How characteristic exhaust velocity is defined ?
4. What is divergence factor for conical nozzle ?
5. Name some examples for solid propellant binders.
6. What is meant by three dimensional burning ?
7. Write the advantages of hybrid rocket propulsion over liquid and solid rocket propulsion.
8. Show the equation that represents the pressure dependence on burn rate.
9. What is the principle of ion propulsion system ?
10. Explain solar sail.

PART – B (5×13=65 Marks)

11. a) Draw the T-S diagram of scramjet engine. Obtain the expression for thermal efficiency of scramjet engine.

(OR)

b) With neat sketch explain the concept of fuel-air mixing in parallel stream of scramjet combustor.

12. a) A rocket projectile has the following characteristics :

Initial mass	200 kg
Mass after rocket operation	130 kg
Payload, nonpropulsive 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 the vehicle, effective exhaust velocity, total impulse and the impulse-to-weight ratio.

(OR)

b) What are the design considerations of a rocket igniter ? What are the different types of igniter used ? Explain.

13. a) i) What are the important factors considered during propellant grain design ? (6)

ii) Mention some oxidizers, fuel and binders of solid propellant with their advantages and drawbacks. (7)

(OR)

b) i) Write short notes on strand burner and T-turner. (5)

ii) Explain the burning rate relation with pressure and temperature in case of solid propellant rocket motor with suitable graph. (8)

14. a) i) Explain typical tank arrangements of liquid rocket engines. (6)

ii) With a neat sketch explain the operation of a turbopump feed system of a liquid propellant rocket engine. (7)

(OR)

b) i) Explain with neat sketch the cooling in liquid rockets motors. (6)

ii) Name any four liquid oxidizers and write their properties. (7)

15. a) Explain the following with neat sketches :

i) Electro thermal thrusters. (6)

ii) Non-electro thermal thruster. (7)

(OR)

b) Explain the working principle of Nuclear Rocket Engine with neat sketches.

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PART – C **(1×15=15 Marks)**

16. a) A scramjet engine as shown in Fig. 11. a) powering an airplane flying at Mach number equal to 5.0 at an altitude of 55,000 ft where Ta = 216.67 K and Pa = 9.122 kPa. Two oblique shock waves are formed in the intake before entering the combustion chamber at supersonic speed and having a deflection angle $\delta = 10°$. Hydrogen fuel is burned that gives rise a maximum temperature of 2000 K. The fuel-to-air ratio is 0.025. The nozzle has an expansion ratio $A_5/A_4 = 5$. The inlet and exit areas of the engine are equal, $A_1 = A_5 = 0.2\ m^2$ and the hydrogen fuel heating value is 120,900 kJ/kg. It is required to

a) Calculate the Inlet Mach number to the combustion chamber.
b) Calculate exhaust jet velocity.
c) Calculate the overall efficiency.

Cp = 1.51 kJ/kg K, Yn = 1.238 and burner efficiency is 0.8.

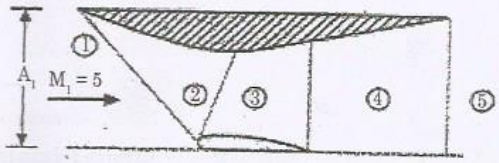

Fig. 11. a)

(OR)

b) A solid propellant rocket comprises a hollow cylindrical composite propellant grain having an inner diameter of 200 mm and outer diameter of 600 mm. The length of the grain is 1.5 meter. The propellant grain is inhibited from burning at both ends. The burning is radially outward from the inner cylindrical surface. A convergent divergent nozzle, attached at the aft-end of the grain, has a throat diameter of 100 mm. The propellant data is given below : $a_{70} = 6$ mm/s. Burn rate index "n" in burn rate law $r = {}_aP^n$ is 0.35, characteristic velocity of the propellant is 1400 m/s, Density of propellant is 1600 kg/m^3.

Determine the following :

a) Maximum chamber pressure.
b) Burn duration of the solid propellant rocket.

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