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

Question Paper Code : 50029

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2017

Fifth Semester

Aeronautical Engineering

AE6504 : PROPULSION – II

(Regulations 2013)

Time : Three Hours | Maximum : 100 Marks

Answer ALL questions

PART – A (10×2=20 Marks)

1. Define Specific impulse.
2. What is the need of isolator in the scramjet engine ?
3. Define mixture ratio. State its importance.
4. What is meant by internal ballistics properties ?
5. Name some examples for solid propellant binders.
6. What is meant by three dimensional burning ?
7. Differentiate the blow-down and regulated cold gas propellant feeding system.
8. Name some propellants for reverses hybrid rocket.
9. What are the subsystems found in electric propulsion thruster ?
10. What is meant by space charged density ?

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) Explain in detail about the major components of horizontal static test stand used in rocket test facilities.

(OR)

b) i) Explain in detail about the ignition events and factors which affecting the ignition of propellant grains. (7)

ii) For an ideal rocket with a characteristic velocity c* = 1500 m/sec, a nozzle throat diameter of 18 cm, a thrust coefficient of 1.38 and a mass flow rate of 40 kg/sec, compute the chamber pressure, the thrust and the specific impulse. (6)

13. a) i) With neat sketch explain the various types of solid rocket motor casing and their design consideration. (6)

ii) How can you evaluate the burning time of a hollow cylindrical grain ? (7)

(OR)

b) i) A solid propellant has a burning rate of 20 mm/s at a standard initial propellant bulk temperature of 20°C and temperature sensitivity of $0.004K^{-1}$. Determine the approximate new burning rate if the initial bulk temperature is changed to : (6)

1) 65°C

2) –25°C.

ii) Explain in detail about the various factors affecting the burning rate of the solid propellant. (7)

14. a) A liquid propellant rocket developing a thrust of 500 N uses MMH and N_2O_4 for the propellant at a mixture ratio of 1.65. The chamber pressure is 0.7 MPa. The value of the characteristic velocity C* of the propellant at the above chamber pressure and mixture ratio of 1.65 is 1800 m/s. The thrust coefficient C_F of the rocket is 1.5.

Determine the following :

a) Throat area of the nozzle

b) Mass flow rate of MMH and N_2O_4

c) The diameter of the injection holes to be provided in the injector for the MMH and N_2O_4 if 10 doublet injector elements are used. The injection pressure of MMH and N_2O_4 is 1 MPa. The discharge coefficient of the orifices is 0.95. The density of MMH is 868 kg/m^3 and the density of N_2O_4 is 1400 kg/m^3.

(OR)

b) i) List out some important desirable physical properties for the liquid propellants. (5)

ii) Explain in detail about the various types of regression rate improvement methods for hybrid rocket fuels. (8)

15. a) Determine the flight characteristics of an electrical propulsion rocket for raising a low satellite orbit. Data given :

Specific impulse	=	2000 sec
Thrust	=	0.20 N
Duration	=	2.42×10^6 sec
Payload mass	=	100 kg
Specific power	=	100 W/kg
Thruster efficiency	=	0.5

Determine the propellant flow rate, the total mass of the propellant, the required electric power, the mass before and after engine operation, incremental velocity and average acceleration of the vehicle.

(OR)

b) i) Explain the general design criteria that desirable for the electrostatic thrusters regardless of the charged particle source. (6)

ii) With neat sketch explain the working principle of nuclear rocket engine. (7)

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 = 216.67K 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.

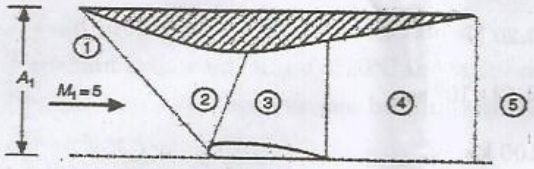

Fig 11.a

(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.