



B.E DEGREE EXAMINATIONS: MAY 2015

(Regulation 2009)

Sixth Semester

AERONAUTICAL ENGINEERING

AER116: Rocket Propulsion

Time: Three Hours

Maximum Marks: 100

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

- The rocket engine will develop maximum thrust when the ratio of the atmospheric pressure to the nozzle exit pressure (P_{atm}/P_{exit}) is _____.
 - equal to one
 - less than one
 - greater than one
 - 1.78
- The specific impulse of chemical rocket range typically _____.
 - 1000-2000 s
 - 150-450s
 - 5000-8000 s
 - above 8000
- Which one of the following ingredient is the most important in terms of both bulk and function of an igniter with black powder?
 - Charcoal
 - Sulfur
 - Potassium nitrate
 - PVC
- If we double the rocket thrust (F) by increasing the characteristic length scale, how does its thrust to weight ratio (F/W) vary?
 - 1
 - 2
 - $\frac{1}{2}$
 - $1/2^{1/2}$
- At the choked flow condition the rocket nozzle area ratio (A_{exit}/A_{throat}) is a unique function of _____.
 - chamber pressure and nozzle exit pressure ratio
 - mass flow rate
 - throat pressure and nozzle exit pressure ratio
 - throat temperature and exit temperature ratio.
- _____ is used in comparing the relative performance of different chemical rocket propulsion systems design and propellants.
 - Chamber pressure
 - Characteristics velocity
 - Nozzle area ratio
 - Exhaust velocity

(ii) A 5,000 kg spacecraft is in Earth orbit traveling at a velocity of 7,790 m/s. Its engine is burned to accelerate it to a velocity of 12,000 m/s placing it on an escape trajectory. The engine expels mass at a rate of 10 kg/s and an effective velocity of 3,000 m/s. Calculate the duration of the burn. (7)

22. a) (i) Describe briefly Pyrogen igniter and discuss the effects of igniter size on internal ballistics of solid rockets. (7)

(ii) Describe briefly the physical process involved in solid propellant ignition and the subsequent flame spread period in a solid rocket motor. (7)

(OR)

b) (i) Describe briefly Pyrotechnic igniter. (7)

(ii) What are the parameters considered for the design of a solid rocket igniter? (7)

23. a) (i) Using the initial and the final mass of a rocket derive an expression for its change in velocity (ΔV). Clearly explain the assumptions made in deriving the rocket equation. (7)

(ii) A two-stage rocket has the following masses: 1st-stage propellant mass 120,000 kg, 1st-stage dry mass 9,000 kg, 2nd-stage propellant mass 30,000 kg, 2nd-stage dry mass 3,000 kg, and payload mass 3,000 kg. The specific impulses of the 1st and 2nd stages are 260s and 320s respectively. Calculate the rocket's total ΔV . (7)

(OR)

b) (i) Describe briefly the design considerations of a solid rocket motor. (7)

(ii) Describe briefly the thrust vector control mechanisms in solid rockets. (7)

24. a) (i) Derive an expression for the exit velocity of a liquid rocket. (7)

(ii) Explain briefly the working of a liquid rocket engine with gas-generator cycle. (7)

(OR)

b) (i) Explain briefly the following cooling techniques used in liquid rockets. (6)
(a) film cooling, (b) transpiration cooling, (c) ablative cooling

(ii) A rocket engine burning liquid oxygen and kerosene operates at a mixture ratio of 2.26 and a combustion chamber pressure of 5 MPa. If the nozzle is expanded to operate at sea level, calculate the exhaust gas velocity relative to the rocket. If the propellant flow rate is 500 kg/s calculate the area of the exhaust nozzle throat. Given: $T_c = 3,470$ K ; Gas molecular weight = 21.40 ; $k = 1.221$. (8)

25. a) (i) Describe briefly electric rocket propulsion (7)
(ii) Describe briefly nozzle-less propulsion (7)

(OR)

- b) Write short notes on any FOUR of the following: (a) Hybrid rocket propulsion, (b) Ion propulsion, (c) Nuclear rocket, (d) Ram rocket (e) Antimatter propulsion, (f) Interstellar flight.
