KUMARAGURU college of technology
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Register Number: …….

B.E DEGREE EXAMINATIONS : APRIL/ MAY 2016

(Regulation 2013)

Sixth Semester

AERONAUTICAL ENGINEERING

U13AET605**:** Rocket Propulsion

Time: Three Hours **Maximum Marks: 100**

Answer all the Questions:-

PART A (10 x 1 = 10 Marks)

1. In a quiet atmosphere the force(s) which determine the trajectory of a stable powered rocket without misalignment is/are _____.
   a) only gravity b) only thrust
   c) thrust and drag d) gravity, thrust and drag
2. The rocket engine will develop maximum thrust when the ratio of the atmospheric pressure to the nozzle exit pressure (P_{atm}/P_{exit}) is _____.
3. Which one of the following ingredient is the most important in terms of both bulk and function of an igniter with black powder?
   a) Charcoal b) Sulfur
   c) Potassium nitrate d) PVC
4. _____ phenomenon describes subsonic combustion that usually propagates through thermal conductivity.
5. The specific impulse of solid propellant rocket range typically _____.
   a) 1000 - 2000 s b) 150 - 450 s
   c) 5000 - 8000 s d) above 8000 s
6. The solid rocket motor will become unstable when the numerical value of the solid propellant burn rate ($r = aP_c^n$) index *n* is _____.
7. _____ is used in comparing the relative performance of different chemical rocket propulsion systems design and propellants.
   a) Chamber pressure b) Nozzle area ratio
   c) Characteristics velocity d) Exhaust velocity
8. The phenomenon of low combustion instability (10 – 400 Hz) in a liquid propellant rocket is popularly termed as_____.

9. The rocket engines, which are used liquid oxidizer and a solid fuel are called _____ rocket.

a) Hybrid b) Electric

c) Liquid d) Nuclear

10. _____ type of spacecraft do not need to carry an active main propulsion system nor any propellant for it.

PART B (10 x 2 = 20 Marks)

(Answer not more than 40 words)

11. Define specific impulse and characteristics velocity of a rocket.
12. What is the function of a rocket nozzle?
13. Name any two different types of igniters used in solid rockets.
14. Differentiate between deflagration and detonation.
15. What is the purpose of staging of rockets?
16. Sketch the pressure-time curve of a cylindrical rocket grain with radial burning.
17. What is Geysering effect and how to eliminate it in liquid rocket engines?
18. Differentiate between chugging and screeching phenomena in liquid rockets.
19. What is solar sail?
20. Differentiate between Cryogenic rockets and Electric rockets.

PART C (5 x 14 = 70 Marks)

(Answer not more than 400 words)

Q.No. 21 is Compulsory

21. (i) Explain the working principle of a rocket. (7)

(ii) An ideal rocket is having a characteristic velocity of 1200 m/s, a mass flow rate of 70 kg/s, a thrust coefficient of 1.5 and a nozzle throat area of 0.024 m^2, calculate the thrust, specific impulse and the effective exhaust velocity. (7)

22. (a) (i) Describe briefly Pyrotechnic igniter. (7)

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

(OR)

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

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

23. (a) (i) Derive the rocket equation in terms of change in velocity (ΔV) and mass ratio. (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. (7)

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

24. (a) (i) Explain briefly the working of a liquid rocket engine with regenerative cooling system. (7)

(ii) Explain briefly the following cooling techniques used in liquid rockets. (7)

(1) film cooling, (2) transpiration cooling, (3) ablative cooling.

(OR)

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

(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. (7)

Given: Combustion temperature = 3470 K; Gas molecular weight = 21.40; Specific heat ratio = 1.221. Universal Gas constant = 8314.51 N-m/kg-^{o}K.

25. (a) (i) Describe briefly electric rocket propulsion. (7)

(ii) Describe briefly nozzle-less propulsion. (7)

(OR)

(b) Write short notes on the following: (i) Hybrid rocket propulsion, (ii) Cryogenic Rocket, (iii) Nuclear rocket, (iv) Satellite Thrusters.

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