KUMARAGURU
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B.E DEGREE EXAMINATIONS: APRIL / MAY 2024

(Regulation 2018)

Sixth Semester

AERONAUTICAL ENGINEERING

U18AET6104**:** Rocket Propulsion

COURSE OUTCOMES

CO1: Illustrate the Basic principles and parameters of rockets.
CO2: Differentiate and interpret the ignition systems of rocket
CO3: Analyze the performance of solid-core nuclear thermal rockets, arc jets, and ion thrusters.
CO4: Analyze the performance of Liquid Propellant Rockets
CO5: Interpret the advanced propulsion techniques of a rocket

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

Answer all the Questions: -
PART A (10 x 2 = 20 Marks)
(Answer not more than 40 words)

1.	Differentiate between mono propellant and bipropellant rocket engine.	CO1	[K$_2$]
2.	Define thrust coefficient.	CO1	[K$_1$]
3.	What is meant by squib in solid rocket motor?	CO2	[K$_2$]
4.	List down the requirements of ignitor design.	CO2	[K$_1$]
5.	Define staging in rocket engine.	CO3	[K$_1$]
6.	What is meant by thrust vectoring and mention its types?	CO3	[K$_2$]
7.	What is meant by atomization?	CO4	[K$_2$]
8.	List out the types of injectors used in liquid propellant engine.	CO4	[K$_1$]
9.	Define nozzleless propulsion.	CO5	[K$_1$]
10.	Differentiate between Cryogenic rockets and Electric rockets.	CO5	[K$_2$]

Answer any FIVE Questions: -
PART B (5 x 16 = 80 Marks)
(Answer not more than 400 words)

11.	Define the following performance parameters.	16	CO1	[K$_2$]

    i) Specific impulse and Total impulse ii) Effective exhaust velocity and

    Characteristic velocity iii) Impulse to weight ratio and Thrust to weight ratio

    iv) Internal efficiency and Propulsive efficiency

12. a) Briefly discuss about working principle of pyrogen and pyrotechnic igniter and processes of ignition. 12 CO2 [K₂]

b) Write a short note on deflagration and detonation. 04 CO2 [K2]

13. a) During the testing of new propellant in a stand burner the regression rate at two chamber pressure of 7 MPa and 17 MPa are found to be 25 mm/s and 45 mm/s respectively. If the regression rate happens to the follow the Saint Roberts law,determie the chamber pressure when it regressions at 35 mm/s. 06 CO3 [K₄]

b) An end burning rocket employs double base propellant (ρ_p = 1900 kg/m³) grain with a diameter of 125 mm and generates 205N thrust over 215 seconds with characteristics velocity of 1350 m/s and thrust coefficient of 1.2.The pressure/combustion index and burning rate constant of this propellant are 0.7 and 3.2 for the regression rate expression $r=a_1(P_c/P_R)^n$; P_R=7MPa.Determine the length of the grain, chamber pressure and throat diameter. 10 CO3 [K₄]

14. a) With neat sketch, explain the working principle of gas pressure and turbopump pressure feed system in liquid rocket engine. 08 CO4 [K₂]

b) With neat sketch, briefly discuss about different types of liquid propulsion ignition systems. 08 CO4 [K₂]

15. a) Write a short note on solar sail and anti-matter propulsion. 08 CO5 [K₃]

b) With neat sketch, briefly discuss about nuclear rocket propulsion. 08 CO5 [K₃]

16. The following measurements were made in a sea-level test of a solid propellant, rocket motor (all cross sections are circular and unchanging): 16 CO1 [K₄]
Burn duration 40 sec, Initial propulsion system mass 1210 kg, Mass of rocket motor after test 215 kg, Sea-level thrust 62,250 N, Chamber pressure 7.00 MPa Nozzle exit pressure 70.0 kPa, Nozzle throat diameter 8.55 cm, Nozzle exit diameter 27.03 cm, Determine ṁ, V_2, c∗, and c at sea level. Also, determine the pressure thrust and the specific impulse at sea level, 1000 m, and 25,000 m altitude. Assume that the momentum thrust is invariant during the rocket ascent, and that start and stop transients can be neglected.

Altitude	p_3 (kPa)
Sea level	101.32
1000 m	89.88
25,000 m	2.55

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