MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING
(A Unit of Rajalaxmi Education Trust®, Mangalore)
Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE, New Delhi
Accredited by NAAC with A+ Grade & ISO 9001:2015 Certified Institution

Model Question Paper

Seventh Semester BE Degree Examination

Rocket Propulsion and Propellants

Time: 3Hours (180 Minutes) **Max. Marks: 100**

Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.
2. M: Marks, L: RBT (Revised Bloom's Taxonomy) level, C: Course outcomes.

		Module -1	M	L	C
Q1	a.	A rocket projectile has the following characteristics: Initial mass200 kg Mass after rocket operation130 kg Payload, non-propulsive structure, etc.110 kg Rocket operating duration3.0 sec Average specific impulse of propellant240 sec Determine the vehicle's mass ratio, propellant mass fraction, and propellant flow rate, thrust, and thrust-to-weight ratio, acceleration of the vehicle, effective exhaust velocity, total impulse, and the impulse-to-weight ratio.	12	L3	CO5
	b.	Derive an expression for ideal nozzle exhaust velocity with the assumptions involved in	08	L3	CO5
		OR			
Q2	a.	The inlet conditions for rocket nozzle are given by total temperature 2800 K, total pressure 43 bar and the inlet velocity can be neglected when compared to nozzle outlet velocity. The nozzle throat diameter is 5.2 cm. Estimate the mass flow rate through the nozzle. Assuming optimum expansion at sea level, determine nozzle exit velocity, exit Mach number and the thrust developed by the rocket unit. Take ratio of specific heat as 1.35.	12	L3	CO5
	b.	Apply the concept of characteristic velocity and specific impulse to evaluate the performance of a rocket engine. If a rocket produces 150 kN thrust with a propellant mass flow rate of 50 kg/s, determine the specific impulse of the engine and comment on its performance efficiency.	08	L3	CO5
		Module- 2			
Q3	a.	Explain briefly the following terms in solid propellant rocket, Linear burning rate Combustion rate ,Propulsion area ratio, Equilibrium combustion pressure, Cigarette burning	10	L2	CO2
	b.	Derive the relations for pressure and temperature sensitivity of solid propellants used in rocket motors	10	L3	CO3
		OR			
Q4	a.	Explain the characteristics of solid propellants and differentiate between detonation and deflagration.	10	L2	CO2
	b.	Derive the relationship between propellant composition and combustion performance, explaining how oxidizer, fuel, and binder proportions influence the overall energy release and combustion efficiency of a solid propellant.	10	L3	CO3

Module - 3					
Q5	a.	A cylindrical solid propellant grain has a web thickness of 30 mm**.** If the burning rate of the propellant is 5 mm/s, determine the total burning time of the propellant grain**.**	10	L3	CO3
	b.	Sketch and explain the propellant grain and grain configurations used in solid propellant rockets motors	10	L2	CO1
OR					
Q6	a.	A solid rocket propellant follows Saint Robert's burning rate law, where the burning rate r is related to chamber pressure P by the relation $r=aP^n$ where a is the burn rate coefficient and n is the pressure exponent. For a particular solid propellant, the burn rate coefficient a=0.005 m/s and the pressure exponent n=0.35. If the chamber pressure is 6 MPa, determine the burning rate of the propellant**.**	10	L3	CO3
	b.	Explain the combustion of solid propellants with different zones of ignition	10	L2	CO1
Module – 4					
Q7	a.	Explain the working principle of a liquid rocket motor with turbo pump feed system with neat sketch.	10	L2	CO1
	b.	A liquid rocket engine uses Liquid Oxygen (LOX**)** as the oxidizer and RP-1 kerosene as the fuel. The oxidizer mass flow rate is 24 kg/s and the fuel mass flow rate is 6 kg/s**.** i. Calculate the oxidizer-to-fuel ratio (O/F)**.** ii. If the rocket operates for 120 seconds, determine the total mass of propellant consumed**.**	10	L3	CO4
OR					
Q8	a.	Explain the working principle of a liquid rocket motor with gas pressure feed system with neat sketch.	10	L2	CO1
	b.	A chemical rocket is used for launch into earth orbit. At the end of the combustion chamber the stagnation temperature is 3000 K. The molecular weight of the combustion product is 26. The gases expand isentropically as an ideal gas mixture with specific heat ratio 1.2. The area ratio Ae/A* of the nozzle is 20 & the throat is 0.1 m in diameter. At sea level, determine: The stagnation pressure if the expansion is optimum	10	L3	CO4
Module – 5					
Q9	a.	With a neat sketch explain the operation of a hybrid rocket. What are its advantages and limitations?	10	L2	CO2
	b.	Describe the ignition process in hybrid rocket propellants and explain the factors affecting the combustion characteristics of hybrid rockets.	10	L2	CO2
OR					
Q10	a.	Classify the hybrid propellants used in rocket combustions using suitable chemical equations	10	L2	CO2
	b.	Explain the concept of green propellants used in rocket propulsion. Discuss the types of green propellants such as oxidizers, fuels, and monopropellants, and explain their environmental and operational advantages.	10	L2	CO2

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