

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI
(END SEMESTER EXAMINATION)**

CLASS: MTECH/Pre-PhD
BRANCH: SER

SEMESTER: I
SESSION: MO-2025

SUBJECT: SR501 ELEMENTS OF ROCKET PROPULSION

TIME: 3 Hours

FULL MARKS: 50

INSTRUCTIONS:

1. The question paper contains 5 questions each of 10 marks and total 50 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Before attempting the question paper, be sure that you have got the correct question paper.

Q.1(a)	What is the benefit of using a nozzleless rocket? Also write the main characteristics which are needed for it.	[2]	CO1	BL L2
Q.1(b)	Explain with suitable figure and justification, why an airframe and a propulsion system need to be matched?	[3]	CO1	L3
Q.1(c)	Explain the working principle of a turbofan engine with suitable sketch? Also explain in brief how its uses from military to civilian aircraft changes?	[5]	CO1	L4
Q.2(a)	Explain in brief how an inhibitor is different from an insulator?	[2]	CO2	L2
Q.2(b)	Explain why increase in oxidizer percentage in the solid composite propellant increases their burn rate?	[3]	CO2	L3
Q.2(c)	Explain the combustion mechanism of a liquid rocket with suitable sketch.	[5]	CO2	L4
Q.3(a)	What are the main assumptions made for an ideal rocket?	[2]	CO3	L2
Q.3(b)	Why optimally expanded flow ($p_e = p_a$) is said to give maximum thrust? Give justification with respect to other nozzle condition that is under expanded and over expanded condition.	[3]	CO3	L3
Q.3(c)	Derive equation for mass flow rate under the choked flow condition in terms of chamber pressure, throat area and characteristic velocity.	[5]	CO3	L4
Q.4(a)	What do you mean by steady method of cooling? Provide sufficient explanation for this.	[2]	CO4	L2
Q.4(b)	Why regenerative method of cooling is called most efficient method of cooling in a liquid rocket engine? Justify this with respect to other methods of cooling.	[3]	CO4	L3
Q.4(c)	A Deepawali rocket generates a chamber pressure (P_c) of 1.8 bar and the ambient pressure (P_a) of 1 atm. Assume flow to be optimally expanded that is $P_e = P_a$. The chamber temperature (T_c) was 2750 K, molecular weight was 22, $\gamma = 1.2$. It gives 7 N of thrust. Calculate the specific impulse, I_{sp} and the thrust coefficient C_F generated by the rocket.	[5]	CO4	L4
Q.5(a)	What are various types test that were done before they are put in operational practical use?	[3]	CO5	L3
Q.5(b)	What are the various types of instrument errors that are normally observed to occur during the measurement?	[3]	CO5	L3
Q.5(c)	What are the various procedures that are followed after the post-accident at the rocket launch site?	[4]	CO5	L3

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