

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

**CLASS: MTECH
BRANCH: AEROSPACE ENGINEERING**

**SEMESTER : II
SESSION : SP/2025**

SUBJECT: SR523 COMBUSTION INSTABILITIES IN ROCKET ENGINES

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.
 5. Tables/Data hand book/Graph paper etc. to be supplied to the candidates in the examination hall.
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		CO	BL
Q.1(a) Provide a detailed classification of combustion instabilities in rocket engines.	[5]	1	3
Q.1(b) How perturbation amplitudes can be used to determine amplifying and damping mechanisms in rocket engines? Describe only using sketches.	[5]	2	5
Q.2(a) Suggest a method for effective damping of oscillations in SRMs.	[5]	5	4
Q.2(b) Briefly describe an experimental method for characterization of L ⁺ -instability.	[5]	2	3
Q.3(a) Two stability conditions pertaining to chugging in LRE are given by the following inequalities d1: $\frac{l_2}{p_c} \frac{\dot{m}}{A_2} + \frac{c^* L^*}{RT_c} > \tau$ and d2: $\frac{2\Delta p}{p_c} > 1$. Interpret these conditions	[5]	3	4
Q.3(b) Using the above stability conditions, suggest measures to suppress or control chugging.	[5]	5	4
Q.4 A rocket assisted aircraft using a hypergolic liquid rocket power plant has the following specifications: $l_2 = 1.5$ m, $d_2 = 0.0635$ m, $\dot{m} = 11.2$ kg/s, $P_{inj} = 3.445$ MPa, $P_c = 2.76$ MPa, $c^* = 1525$ m/s, $R = 34$ J/kg K, $T_c = 3058$ K, $L^* = 1.524$ m, $F = 22.2$ kN. Using these specifications and with the help of Summerfield stability conditions:			
Q.4(a) Determine if the vehicle could suffer from chug.	[2]	4	5
Q.4(b) Determine the critical time delay ($\tau_{d,crit}$) for the power plant.	[4]	4	5
Q.4(c) If $\tau_d = 5-30$ ms for typical hypergols, comment on the severity of chugging problem and the critical l_2 for which chugging will be eliminated.	[4]	4	5
Q.5(a) Provide a complete sequence of steps required to characterize an unstable HRM.	[5]	1,2	3
Q.5(b) Describe thermal lag, acoustic diffusion, and axial diffusion timescales for the dynamic processes in a HRM and arrange them in the increasing order-of-magnitudes.	[5]	1,2	3

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