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| **Name:**<br>**Enrolment No:** | UPES<br>UNIVERSITY OF TOMORROW |

**UPES**
**End Semester Examination, May 2024**

**Course: Rocket Propulsion** **Semester: VIII**
**Program: B.Tech ASE** **Time : 03 hrs.**
**Course Code: ASEG 4011P** **Max. Marks: 100**

**Instructions: All questions are compulsory**
**Assume necessary data if not given.**

**SECTION A**
**(5Qx4M=20Marks)**

| S. No. | | Marks | CO |
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| Q 1 | How the Gas generator based propellant feed systems works in liquid rocket engine. | **4** | **CO1** |
| Q 2 | What is the importance of igniters in rocket motors? | **4** | **CO3** |
| Q 3 | How Multi staging of rockets helps in increasing its performance. | **4** | **CO3** |
| Q 4 | What are the advantages of electrical propulsion engines (thrusters) over chemical rocket engines? | **4** | **CO4** |
| Q 5 | How Combustion Instability occurs in the rocket engines and explain the methods to control Instabilities? | **4** | **CO1** |

**SECTION B**
**(4Qx10M= 40 Marks)**

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| Q 6 | Describe in detail the design process involved in conducting burn rate studies for solid propellant strands, and elaborate on the procedures and methodologies employed for performance estimation tests conducted within the Space Technology Lab. | **10** | **CO4** |
| Q 7 | The following measurements were made in a sea level test of a solid propellant rocket motor:<br>Burn duration 40 sec<br>Initial mass before test 1210kg<br>Mass of rocket motor after test 215kg<br>Average thrust 62,250 N<br>Chamber pressure 7.00 MPa<br>Nozzle exit pressure 0.070 MPa<br>Nozzle throat diameter 0.0855 m<br>Nozzle exit diameter 0.2703 m<br>Determine mass flow rate (m.), $V_2$, $C^*$, C, and Is at 1000 and 25000 m altitude. Assume an invariant thrust and mass flow rate and negligible short | **10** | **CO1** |

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| | start and stop transients. (At 1000, Pa= 0.0898 MPa and At 25000 m, Pa= 0.00255 MPa)<br>**OR**<br>A rocket has a total mass of 5000 kg, including propellant. Its specific impulse is 300 seconds, and its propellant flow rate is 50 kg/s. The rocket is launched vertically upwards and experiences negligible air resistance.<br>(a) What is the rocket's initial acceleration? (**3 marks**)<br>(b) What is the maximum velocity the rocket can achieve? (**4 marks**)<br>(c) What is the total impulse of the rocket motor during its entire burn time? (**3 marks**) | | |
| Q 8 | Analyze the factors influencing injector behavior in the thrust chamber of Liquid Propellant rocket engines. | **10** | **CO1** |
| Q 9 | Explain the principles of the thrust vector control method used in rockets and discuss its advantages and disadvantages. Then, using appropriate equations, calculate the angle of deflection required for a rocket to change its course by a given angle, and determine the resulting change in velocity. | **10** | **CO3** |
| **SECTION-C**<br>**(2Qx20M=40 Marks)** | | | |
| Q 10 | The Saturn V rocket used by NASA during the Apollo missions was a multistage rocket, consisting of three stages. The first stage used five F-1 engines, the second stage used five J-2 engines, and the third stage used a single J-2 engine. The rocket had a total height of 110 meters and a liftoff mass of 2.8 million kg.<br>(a) Compare and contrast the design of the first, second, and third stages of the Saturn V rocket in terms of their engines, fuel, and performance parameters. (**6 marks**)<br>(b) The first stage of the Saturn V rocket burned for approximately 2.5 minutes before separating from the rest of the rocket. If the first stage had a thrust of 34 million newtons and a specific impulse of 263 seconds, what was its total impulse? (**4 marks**)<br>(c) The second stage of the Saturn V rocket burned for approximately 6 minutes before separating from the rest of the rocket. If the second stage had a thrust of 5 million newtons and a specific impulse of 421 seconds, what was its total impulse? (**4 marks**)<br>(d) If the third stage of the Saturn V rocket had a thrust of 1 million newtons and a specific impulse of 421 seconds, what was its maximum velocity? Assume that the third stage burned for 2 minutes. (**6 marks**)<br>**OR**<br>Analyze the droplet combustion model of Liquid fuel combustion. On what condition the shape of flame front depends. | **20** | **CO4** |
| Q 11 | Can you evaluate and analyze the impact of the successful completion of the crew escape system and Pad Abort Test (L-110-G Vikas engine) on the progress of India's Gaganyaan mission, and the potential significance of the mission for India's position in the global space exploration landscape? | **20** | **CO4** |