Reg.No. \_\_\_\_\_\_\_\_\_\_\_\_



**End Semester Examination – Nov / Dec – 2019**

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| **Code :** | **14AE2022** | **Duration :** | **3hrs** |
| **Sub. Name :** | **ROCKET PROPULSION** | **Max. Marks :** | **100** |

**ANSWER ALL QUESTIONS (5 x 20 = 100 Marks)**

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| **Q. No.** | **Sub Div.** | **Questions** | **Course**  **Outcome** | **Marks** |
| 1. | a. | Differentiate between rocket engine, turbojet engine and ramjet engine. | CO1 | 12 |
| b. | Briefly explain the application of rocket propulsion in various fields of engineering. | CO2 | 8 |
| **(OR)** | | | | |
| 2. |  | A four stage rocket is used to put a satellite of 45 kg mass in LEO. The approximate value of mass of the propellant, mass of structure and jet velocity for each stage are given bellow:   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Stage** | **I** | **II** | **III** | **IV** | | Mass of Propellant | 9250 | 3600 | 1800 | 280 | | Mass of structure including inert mass | 1750 | 580 | 300 | 45 | | Vj (m/s) | 2300 | 2500 | 2500 | 2700 |   Determine :   1. Payload mass fraction of total rocket. 2. Structural mass fraction of each stage. 3. The ideal ΔV provided by each stage and total ΔV.   If the first stage fires for 50 sec, assuming constant mass depletion what would be the acceleration of the rocket during takeoff? | CO2 | 20 |
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| 3. | a. | Illustrate with a neat sketch, the working principle of solid rocket motor. | CO1 | 15 |
| b. | State the advantages and disadvantages of solid rocket motor over liquid engines. | CO1 | 5 |
| **(OR)** | | | | |
| 4. |  | An end burning rocket uses a cylindrical double base propellant grain with a diameter of 200 mm and generates a thrust of 350 N over a period of 300 seconds. The thrust coefficient is 1.15. The characteristics of the propellant are  Density of the propellant grain = 1500 kg/m3  a70 = 4 mm/s, n = 0.5  C\* = 1500 m/s  Determine 1. The length of the grain  2. Throat diameter of the nozzle. | CO2 | 20 |
|  |  |  |  |  |
| 5. | a. | State the advantages of pressure feed system over pump feed system. | CO1 | 6 |
| b. | With a neat sketch, explain fuel rich stage combustion. | CO1 | 14 |
| **(OR)** | | | | |
| 6. |  | The following test was taken from the sea level test of a solid rocket engine to determine the nozzle performance  Burn duration 50 sec  Initial propulsion system mass 1500 kg  Mass of the rocket motor after the test 300 kg  Sea level thrust 65000 N  Chamber pressure 7.5 Mpa  Nozzle exit pressure 80 kpa  Nozzle throat diameter 9 cm  Nozzle exit diameter 35 cm  Determine ,v2, C\* and C at sea level determine the pressure thrust and specific impulse at sea level, 5000 m, 20,000 m altitude take the corresponding pressure as 101325 pa, 53000 pa, 5500 pa. Neglect transient start and stop condition of the motor. | CO2 | 20 |
|  |  |  |  |  |
| 7. |  | Design an ideal nozzle for a rocket that operates at 20 km altitude and delivers 8000 N thrust with a chamber pressure of 3 Mpa and a chamber temperature of 3300 K. Assuming that k= 1.20 and R = 360 J/kg-K, determine the throat area, exit area, throat temperature and exit velocity. Assume the atmospheric pressure at 20 km altitude as 1 kPa and sea level as 0.1013 MPa. | CO2 | 20 |
| **(OR)** | | | | |
| 8. | a. | Explain the working principle of a integral ram rocket with a neat sketch. | CO1 | 16 |
| b. | State the various application of ramjet engine. | CO1 | 4 |
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|  | | **Compulsory**: |  |  |
| 9. | a. | Write down in sequence the different types of test carried out in a rocket engine. | CO1 | 10 |
| b. | Explain the various physical quantities measured in a rocket testing. | CO1 | 10 |