MITE
Invent Solutions

MANGALORE INSTITUTE OF TECHNOLOGY & ENGINEERING
(A Unit of Rajalaxmi Education Trust®, Mangalore)
Autonomous Institute affiliated to VTU, Belagavi, Approved by AICTE, New Delhi
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Model Question Paper
Seventh Semester BE Degree Examination
Spacecraft Systems Engineering

Time: 3 Hours (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.

<table>
<tr><th colspan="3">Module -1</th><th>M</th><th>L</th><th>C</th></tr>
<tr><td rowspan="2">Q1</td><td>a.</td><td>Explain the different operational environments encountered by spacecraft during a mission.</td><td>10</td><td>L2</td><td>CO1</td></tr>
<tr><td>b.</td><td>A spacecraft is placed in a circular Low Earth Orbit (LEO) at an altitude of 400 km above the Earth's surface. Assume the Earth's radius RE=6378 km and the gravitational parameter μ=3.986*1014 m^3/s^2. Calculate the orbital velocity and orbital period of the spacecraft.</td><td>10</td><td>L3</td><td>CO3</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td rowspan="2">Q2</td><td>a.</td><td>Explain the primary objectives of a spacecraft mission and their importance in mission planning.</td><td>10</td><td>L2</td><td>CO1</td></tr>
<tr><td>b.</td><td>A navigation satellite is placed in a Medium Earth Orbit (MEO) at an altitude of 20,200 km above the Earth's surface. Determine the orbital period of the satellite and verify whether it corresponds to a 12-hour orbit.</td><td>10</td><td>L3</td><td>CO3</td></tr>
<tr><td colspan="6">Module- 2</td></tr>
<tr><td rowspan="2">Q3</td><td>a.</td><td>Differentiate between the operating principles of three-axis stabilized spacecraft, pure-spin spacecraft, and hybrid (dual-spin) spacecraft using the spacecraft rotational motion equation.</td><td>10</td><td>L2</td><td>CO1</td></tr>
<tr><td>b.</td><td>Derive the expression for the angular momentum of a rigid body.</td><td>10</td><td>L3</td><td>CO3</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td rowspan="2">Q4</td><td>a.</td><td>Explain the different oscillatory modes of spacecraft attitude motion and describe each mode with its governing dynamic equation.</td><td>10</td><td>L2</td><td>CO1</td></tr>
<tr><td>b.</td><td>Derive the equation of motion for a three-axis stabilized spacecraft with no momentum bias condition.</td><td>10</td><td>L3</td><td>CO3</td></tr>
<tr><td colspan="6">Module - 3</td></tr>
<tr><td rowspan="2">Q5</td><td>a.</td><td>Describe the design requirements of spacecraft and the major factors considered in spacecraft system design.</td><td>10</td><td>L2</td><td>CO2</td></tr>
<tr><td>b.</td><td>A spacecraft designed for launch using a clamp-band interface must withstand launch loads and support multiple subsystems. Apply spacecraft structural design requirements to determine a suitable structural configuration.</td><td>10</td><td>L3</td><td>CO4</td></tr>
<tr><td colspan="6">OR</td></tr>
<tr><td rowspan="2">Q6</td><td>a.</td><td>Interpret the material selection criteria for spacecraft and list the materials used in spacecraft manufacturing.</td><td>10</td><td>L2</td><td>CO2</td></tr>
<tr><td>b.</td><td>A spacecraft structure carries large solar arrays and antenna reflectors that experience vibration during launch and very low-frequency oscillations in orbit. Apply the principles of spacecraft structural dynamics to determine measures for controlling vibration and ensuring structural stability.</td><td>10</td><td>L3</td><td>CO4</td></tr>
<tr><td colspan="6">Module - 4</td></tr>
<tr><td>Q7</td><td>a.</td><td>Classify and interpret the propulsion systems used in spacecraft.</td><td>10</td><td>L2</td><td>CO2</td></tr>
</table>

	b.	During the design of a rocket propulsion system, parameters such as thrust, specific impulse, and propellant mass flow rate must be optimized to improve mission performance. Write a GNU Octave program to analyze the influence of these performance parameters on the efficiency of a rocket propulsion system.	10	L3	CO5
OR					
Q8	a.	Explain the working of a convergent–divergent (C–D) nozzle with a neat diagram showing the variation of Mach number along the nozzle length.	10	L2	CO2
	b.	During the design of a rocket nozzle, the exit-to-throat area ratio (A_e/A_t) is determined from the continuity equation and flow conditions in the nozzle. Write a GNU Octave program to compute and analyze the variation of the exit-to-throat area ratio for different Mach numbers.	10	L3	CO5
Module - 5					
Q9	a.	With a neat diagram, explain a typical spacecraft power system and its block elements.	10	L2	CO2
	b.	A spacecraft subsystem requires an average power of 2 kW during eclipse operation. The battery discharge regulator efficiency is 89%. Determine the power that must supplied by the battery pack to maintain the spacecraft bus during eclipse.	10	L3	CO4
OR					
Q10	a.	Explain the working of the solar dynamic Brayton cycle used in spacecraft power systems.	10	L2	CO2
	b.	A geostationary communication satellite requires a regulated power bus to supply different voltages to its subsystems. Apply spacecraft power management principles to determine a suitable bus configuration and power distribution system.	10	L3	CO4

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