Seat No.: _____ *Enrolment No._____*

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- VIIIth SEMESTER–EXAMINATION – MAY- 2012

Subject code: 180103 **Date: 14/05/2012**

Subject Name: Space Dynamics

Time: 10:30 am – 01:00 pm **Total Marks: 70**

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Common DATA:

Radius of Earth= 6400 km
Mass of Moon= $1.17X10^{21}$kg
Radius of Moon= 1737.1 km
Gravitational constant: $6.67X10^{-11}$N m^2/kg^2
Average Earth to Moon distance= 3,84,400 km

Radius of Sun= $6.955X10^5$ km
Mass of Sun= $1.989X10^{30}$ kg
Mass Of Earth= $5.98X10^{24}$ kg
1AU= $1.495X10^8$ km

Q.1 **(a)** Derive the equation of Orbit for a spacecraft moving in Gravitational field of the Earth. **07**

(b) Obtain the Equation of motion governing the re-entry of any spacecraft in the atmosphere. Hence show how the deceleration during atmospheric entry phase varies with altitude and under what condition it becomes maximum for Ballistic Entry? **07**

Q.2 **(a)** Show with proper derivation how the trajectory of a spacecraft is defined by the conditions at burnout. Also mention which are the necessary conditions for the spacecraft to escape the gravitation of the Earth. **07**

(b) Obtain Newton's law of Gravitation using Kepler's laws. **07**

OR

(b) Explain three types of Entry paths possible while the spacecraft enters the atmosphere also describe Entry corridor. **07**

Q.3 **(a)** Explain heating of a spacecraft while entering the atmosphere and derive the equation for rate of heat input and total heat input to the vehicle while entry. Hence explain the reason behind keeping the nose blunt for reentry vehicles. **07**

(b) Write a short note on Transfer Orbits and hence define Hohmann Transfer Ellipse. Briefly explain the maneuvers carried while launching a spacecraft to moon. **07**

OR

Q.3 **(a)**
1. Derive the equation to obtain Escape velocity of an object. **03**
2. Write a short note on Gravitational potential Energy. **03**
3. Write down Kepler's third law for Elliptical Orbits. **01**

(b)
1. Explain various approximate models of motion are used to study the motion of a spacecraft. **04**
2. Explain Shell theorem, Superposition principle and limitations of Newton's law of motion. **03**

Q.4 **(a)**
1. A launch vehicle with mass of 10000 kg moving radially outward from Earth has a speed of 4 km/s when its engine shuts off 400 km above Earth's surface. Assuming negligible air drag, find the vehicle's velocity when it is 500 km above earth's surface. What maximum height above earth's surface is reached by the rocket? **05**

2. Calculate the Escape velocity for sun on its surface. **02**

(b) At the end of a rocket launch of a spacecraft, the burnout velocity is 8km/s in a direction due North and 7^0 above the local horizontal. The altitude above sea level is 800 km. The burnout point is located at 25^0 above the Equator. Calculate and draw the Trajectory of the space vehicle. **07**

OR

Q.4 **(a)**

1. How does acceleration due to gravity vary over the surface of the Earth? **04**
2. A space craft with mass 5000 kg and a satellite with mass 400 kg are revolving around the earth in same circular orbit of radius 7250 km from Earth's center. What will be the ratio of their Orbital velocities and ratio of their respective Orbital time periods? **03**

Q.4 **(b)** If a spacecraft is circling the Earth in an Orbit 700 km above the surface of Earth and if the spacecraft has to be put into an Elliptical Orbit with moon at the Apogee, What velocity increment has to be given? Neglect the Gravitation of the Moon. **07**

Q.5 **(a)** A satellite is launched from a circular equatorial parking orbit at an altitude of 200 km into a coplanar circular synchronous orbit by using a Hohmann transfer ellipse. Determine the velocity increments for entering the transfer ellipse and for achieving the circular synchronous orbit of radius 35,800 km. **07**

(b) Write and Explain factors behind perturbation of Satellite's Orbit and its positions. **07**

OR

Q.5 **(a)** Two stages of rockets in series are used to launch a space craft. For both the stages Effective exhaust velocity is 2.4 km/s and mass ratio is 0.3 each. Consider that the value of Gravitational acceleration is constant with altitude and burning time for first and second stage are 150 seconds each. If the second stage ends at altitude of 500 km what will be the final trajectory of the space craft? **07**

(b) Explain different types of maneuvers used in a Rocket. What types of Propulsion systems are used to carry out these maneuvers? **07**

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