Hall Ticket No | | | | | | | | | | | Question Paper Code: AAE016

INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal, Hyderabad - 500 043

MODEL QUESTION PAPER - I

B.Tech VII Semester End Examinations, November/December – 2019

Regulations: IARE - R16

SPACE MECHANICS

(AERONAUTICAL ENGINEERING)

Time: 3 hours **Max. Marks: 70**

Answer ONE Question from each Unit

All Questions Carry Equal Marks

All parts of the question must be answered in one place only

UNIT – I

1. a) Discuss the two body problem and the relative motion of the two bodies **[7M]**

   b) Define and write the equation for the conic section. Provide details and specify how one would obtain the eccentricity vector **[7M]**

2. a) Discuss the elliptical orbit. Derive the equation for the elliptical orbit. Also, provide an equation for the period of an elliptical orbit **[7M]**

   b) Define the circular orbit, and the various aspects of the time period of motion of the circular motion. **[7M]**

UNIT – II

3. a) An earth satellite is observed to have a height of perigee of 100 nmi and a height of apogee of 600 nmi. Find the period of the orbit **[7M]**

   b) Six constants of integration (or effectively, 6 orbital elements) are required for a complete solution of the two-body problem **[7M]**

4. a) For a certain earth satellite it is known that the semimajor axis, a is 30 x 10^6 ft. The orbit eccentricity is 0.2. **[7M]**

   b) Prove that apoapsis= a (1+e) **[7M]**

UNIT – III

5. a) A space vehicle enters the sensible atmosphere of the earth (300,000 ft) with a velocity of 25,000 ft/sat a flight path angle of -60Deg. What was its velocity and flight-path angle at an altitude of 100nmi during descent? **[7M]**

   b) Show that the speed of a satellite on an elliptical orbit at either end of the minor axis is the same as local circular sate. **[7M]**

6. a) For a given satellite, E = -2.0x10^8 ft2/sec2 and e=0.2 Determine its specific angular momentum, semi-latus rectum, **[7M]**

   b) A radar tracking station tells us that a certain decaying weather satellite has e=0.1 and **[7M]** perigee altitude = 200 nmi. Determine its altitude at apogee, specific mechanical energy, and specific angular momentum.

UNIT – IV

7. a) Show that two-body motion is confined to a plane fixed in space. **[7M]**
   b) Show that when an object is located at the intersection of the semi-minor axis of an elliptical orbit the eccentricity of the orbit can be expressed as e=-cos v **[7M]**

8. a) Show that the speed of a satellite on an elliptical orbit at either end of the minor axis is same as local circular satellite speed at that point. **[7M]**
   b) What was the Greenwich sidereal time in radians on 3 June 1970 at 17h 00m 00s UT? What is the remainder over an integer number of revolutions? **[7M]**

UNIT – V

9. a) A radar station at Sunyvale, California makes an observation on an object at 2048 hours, PST, 10 January 1970. Site longitudinal is 121.5 Deg. West. What is the local sidereal Time? **[7M]**

   b) Determine the orbital elements by inspection for an object crossing the positive Y axis in a retrograde, equatorial, circular orbit at an altitude of 1 DU. **[7M]**

10 a) A Satellite is orbiting the earth in a 500 nm circular orbit. The ascending node moves to the west, completing one revolution every 90 days. What is the inclination of the orbit? **[7M]**

   b) It is desired that the ascending node make only one revolution every 135 days. Calculate the new orbital inclination required if the satellite remains at the same altitude. **[7M]**

COURSE OBJECTIVES:

I	Impart the knowledge in two-body, restricted three-body and n-body problem, Hamiltonian dynamics, canonical transformations, Poincare surface sections.
II	Analyze the basic Newtonian dynamics and spacecraft altitude dynamics
III	Provide necessary knowledge to study the satellite and interplanetary trajectories and formal approaches for handling coordinate transformations
IV	Solve the orbital problem related to Earth satellite orbits using Hamilton's and generate interplanetary orbits in the frame work of restricted three-body problem.

COURSE OUTCOMES (COs):

CO 1	Understand and develop basic concepts in Space Mechanics
CO 2	Obtain a clear understanding of the Two Body Problem.
CO 3	Develop a clear understanding of the perturbed satellite orbit, and its various implications.
CO 4	Develop a Complete understanding of the Ballistic Missile Trajectories
CO 5	Understand the various aspects of low-Thrust trajectories

COURSE LEARNING OUTCOMES (CLOs):

AAE016.01	Describe the solar system, reference frames, and coordinate systems.
AAE016.02	Explain the celestial sphere, the ecliptic, a motion of vernal equinox, sidereal time, solar time, standard time, and the Earth's atmosphere
AAE016.03	Define and describe the many body problem, and the Lagrange-Jacobi identity.
AAE016.04	Recognize and describe the circular restricted three body problem, libration points, and relative motion in the N-body problem.
AAE016.05	Derive and describe the Equations of motion. Specifically, the general characteristics of motion for different orbits. Understand the relations between position and time for different orbits.
AAE016.06	Define and describe the expansions in elliptic motion, and orbital elements
AAE016.07	Explain the relation between orbital elements and position and velocity. Launch vehicle ascent trajectories, general aspects of satellite injection.
AAE016.08	Discuss the dependence of orbital parameters on in-plane injection parameters, and launch vehicle performances, and orbit deviations due to injection errors.
AAE016.09	Explain special and general perturbations, such as the Cowell's method, & Encke's method
AAE016.10	Understand the method of variations of orbital elements, and the general perturbations approach

AAE016.11	Define the two-dimensional interplanetary trajectories, fast interplanetary trajectories.
AAE016.12	Understand 3D interplanetary trajectories.
AAE016.13	Discuss about the launch of interplanetary spacecraft, and understand the trajectory of the target planet.
AAE016.14	Define and understand the boost phase, the ballistic phase, trajectory geometry and optimal flights.
AAE016.15	Define the time of flight and the re-entry phase.
AAE016.16	Define the position of the impact point and the influence coefficients.
AAE016.17	Understand the equations of motion.
AAE016.18	Understand the constant radial thrust acceleration, constant tangential thrust (Characteristics of the motion), Linearization of the equations of motion, and Performance analysis.

MAPPING OF SEMESTER END EXAMINATION TO COURSE OUTCOMES

SEE Question No.		Course Learning Outcomes		Course Outcomes	Blooms' Taxonomy Level
1	a	AAE016.01	Describe the solar system, reference frames, and coordinate systems	CO 1	Remember
	b	AAE016.02	Explain the celestial sphere, the ecliptic, a motion of vernal equinox, sidereal time, solar time, standard time, and the Earth's atmosphere	CO 1	Understand
2	a	AAE016.03	Define and describe the many body problem, and the Lagrange-Jacobi identity.	CO 1	Remember
	b	AAE016.04	Recognize and describe the circular restricted three body problem, libration points, and relative motion in the N-body problem	CO 1	Understand
3	a	AAE016.07	Derive and describe the Equations of motion. Specifically, the general characteristics of motion for different orbits. Understand the relations between position and time for different orbits.	CO 2	Remember
	b	AAE016.08	Define and describe the expansions in elliptic motion, and orbital elements.	CO 2	Understand
4	a	AAE016.09	Explain the relation between orbital elements and position and velocity. Launch vehicle ascent trajectories, general aspects of satellite injection	CO 2	Understand
	b	AAE016.10	Discuss the dependence of orbital parameters on in-plane injection parameters, and launch vehicle performances, and orbit deviations due to injection errors.	CO 2	Understand
5	a	AAE016.11	Explain special and general perturbations, such as the Cowell's method, & Encke's method.	CO 3	Understand
	b	AAE016.12	Define the two-dimensional interplanetary trajectories, fast interplanetary trajectories	CO 3	Understand
6	a	AAE016.13	Understand 3D interplanetary trajectories.	CO 3	Understand
	b	AAE016.14	Define the two-dimensional interplanetary trajectories, fast interplanetary trajectories.	CO 3	Understand
7	a	AAE016.15	Understand 3D interplanetary trajectories.	CO 4	Remember
	b	AAE016.16	Discuss about the launch of interplanetary spacecraft, and understand the trajectory of the target planet.	CO 4	Remember

8	a	AAE016.17	Define and understand the boost phase, the ballistic phase, trajectory geometry and optimal flights	CO 4	Remember
	b	AAE016.18	Define the time of flight and the re-entry phase.	CO 4	Understand
9	a	AAE016.19	Define the position of the impact point and the influence coefficients.	CO 5	Understand
	b	AAE016.20	Understand the equations of motion.	CO 5	Understand
10	a	AAE016.21	Understand the constant radial thrust acceleration, constant tangential thrust (Characteristics of the motion), Linearization of the equations of motion, and Performance analysis.	CO 5	Remember
	b	AAE016.22	Understand the various trajectory paths	CO 5	Understand

Signature of Course Coordinator **HOD, AE**