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



**End Semester Examination – Nov/Dec– 2017**

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| **Code :** | **14AE2016** | **Duration :** | **3hrs** |
| **Sub. Name :** | **SPACE DYNAMICS** | **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. | From the first principles, derive the rocket equation  Vb = g0Isp ln(Mi/Mf),  WhereVb is the burnout velocity, g0 is the acceleration due to gravity at sea level, Isp is specific impulse and Mi/Mf is the mass ratio. If the Isp of a rocket is 340 s, and Vb is 9800 metres/s, calculate its mass ratio. (g0=9.8 m/s2). | CO1 | 10 |
| b. | A two-stage rocket has the following design characteristics.  First stage: propellant mass = 12000 kg, structural mass = 4000 kg.  Second stage: propellant mass =6000 kg, structural mass = 1800 kg.  The payload mass is 100 kg. The specific impulse for both the stages is 360 s. Calculate the final burnout velocity (g0=9.8 m/s2). | CO1 | 10 |
| (OR) | | | | |
| 2. | a. | Explain static stability margin. | CO1 | 5 |
| b. | Explain the purpose of fins on a rocket.Explainstatic and dynamicstability of rockets. | CO1 | 15 |
| 3. | a. | Write Kepler laws of motion. Use third law of motion to calculate the orbital period of Mars if its distance from Sun is 1.524 Astronomical Units (AU). | CO2 | 8 |
|  | b. | From the Kepler’s equation M = E – e sin E, where e is the eccentricity of an elliptic orbit and E and M are eccentric and mean anomaly, respectively, if E = 70 degrees and e = 0.1, calculate the mean anomaly M in degrees. If the semi-major axis (a) is 8400 km, find the radial distances(r) if eccentric anomaly (E) and true anomaly (f) are 80 and 120 degrees, respectively. | CO2 | 12 |
| (OR) | | | | |
| 4. | a. | Define vernal equinox. Explain geocentric-inertial and heliocentric-inertial coordinate systems. | CO2 | 9 |
|  | b. | Define Sun-synchronous orbit. Calculate the orbital inclination for an ellipticSun-synchronous orbit, whose semi-major axis is 7200 km and eccentricity is 0.02.Earth’s gravitational constant (μ ) = 398600 km3s-2,J2= 0.00108263 and Earth’s radius is 6378 km. | CO2 | 11 |
| 5. | a. | Find the additional velocity required for a Hohmann transfer from a  circular Earth satellite orbit of radius 8000 km to a circular Earth  satellite orbit of radius 11000 km. | CO2 | 10 |
|  | b. | Calculate the velocity change required to transfer a satellite from a circular orbit of 500 km altitude with an inclination of 40°to an orbit of the same size at an inclinationof 10°.Earth’s gravitational constant = 398600 km3s-2. | CO2 | 6 |
|  | c. | Calculate the synodic period of Venus relative to the Earth. The orbital periods of Earth and Venus are 365.26 days and 225 days, respectively. | CO2 | 4 |
|  |  |  |  |  |
| (OR) | | | | |
| 6. | a. | Name three important perturbing forces acting on an Earth satellite. Explain briefly one of the perturbing forces. | CO2 | 7 |
|  | b. | Explain Cowell’s and Encke's methods. Give their advantages and disadvantages. | CO2 | 13 |
| 7. | a. | Draw a neat sketch of hyperbolic trajectory. Show in the sketch, true anomaly of the asymptote, turn angle, periapsis, apoapsisand semi-major axis. | CO2 | 6 |
|  | b. | Calculate the radius of sphere of influence of the Earth. The mass of Earth and Sun are 5.972x1024 kg and 1.989 x1030 kg, respectively. The radius of the Earth’s orbit about the Sun is 149.6x106 km. | CO2 | 5 |
|  | c. | At a given point of a spacecraft’s geocentric trajectory, the radius is 16500 km, the speed is 8.3 km/s, and the flight path angle is 45 degrees. Show that the path is a hyperbola. Calculate the hyperbolic excess velocity, angular momentum, true anomaly and eccentricity of the orbit. Earth’s gravitational constant = 398600 km3s-2. | CO2 | 9 |
| (OR) | | | | |
| 8. | a. | Describe briefly Earth's atmosphere. | CO2 | 10 |
|  | b. | A geocentric trajectory has perigee velocity of 13 km and perigee altitude of 350 km. Find its eccentricity. Earth’s gravitational constant is 398600 km3s-2. | CO2 | 5 |
|  | c. | Using Kepler’s third law, estimate the trip time T from the Earth to Mars along the Hohmann transfer orbit by assuming the orbits of Earth and Mars around the Sun to be circular with radii of 149.6 x 106 and 227.9 x 106 km, respectively. The value of the Sun’s gravitational constant (µ) = 1.32715 x 1011 km3s-2. | CO2 | 5 |
|  | | **Compulsory**: |  |  |
| 9. | a. | Draw a neat diagram to show the six orbital elements of a satellite moving in an elliptic orbit. | CO2 | 5 |
|  | b. | If the position and velocity of a satellite are (6472.7, -7470.8, -2469.8) and (3.9914, 2.7916, -3.2948) km/s, respectively; find the angular momentum and the orbital elements: eccentricity (e), inclination (i), argument of perigee (ω), right ascension of ascending node (Ω) and true anomaly of the satellite. | CO2 | 15 |

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