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



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

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| **Code :** | **14AE2033** | **Duration :** | **3hrs** |
| **Sub. Name :** | **ADVANCED 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. | Define a central orbit. Write its equation of motion. Prove that its angular momentum is constant. Prove that the motion takes place in a plane. | CO1 | 8 |
| b. | Find the center of mass of Sun-Earth system. Masses of Sun and Earth are 1.989 x 1030 kg and 5.974 x 1024 kg, respectively. The distance between them is 149.6 x 106 km. | CO1 | 2 |
| c. | If two point masses m1 and m2 are acted upon only by the mutual force of gravity between them, prove that the centre of mass of this system moves with constant velocity in a straight line. | CO1 | 10 |
| (OR) | | | | |
| 2. |  | Explain Lambert’s problem. Derive Lambert’s theorem analytically. | CO1 | 20 |
|  |  |  |  |  |
| 3. | a. | Name four perturbing forcesacting on a satellite. | CO1 | 4 |
|  | b. | Prove that the change in the semi-major (a) of a satellite with respect to the eccentric anomaly (E) under the effect of the atmospheric drag is given by | CO1 | 8 |
|  | c. | Explain osculating and mean orbital elements. Which perturbing forces effects are included in the SGP4 model? | CO1 | 6 |
|  | d. | From the following Two Line Elements, what are the values of orbital inclination and eccentricity?  1 31928U 98067BA 08308.09345035 .17190483 12785-4 12006-3 0 5450  2 31928 51.6114 326.0951 0003389 293.1214 66.9539 16.52997681 74557 | CO1 | 2 |
| (OR) | | | | |
| 4. | a. | Define Hamiltonian. Write Hamilton’s equations. | CO1 | 3 |
|  | b. | A mechanical system depending on two coordinates x and y has kinetic energy T = y2 ẋ2 + 2 ẏ2 and potential energy V = x2 – y2. Write down the Lagrangian for the system and the Lagragian equations of motion. Write its Hamiltonian and the Hamilton’s equations of motion. | CO1 | 17 |
|  |  |  |  |  |
| 5. | a. | Define a canonical transformation. | CO1 | 2 |
|  | b. | Prove that the following transformation is canonical:  P = - tan-1 (q/p), Q = (q2 + p2)/2. | CO1 | 3 |
|  | c. | Prove that the following transformation is canonical:  P = log (sin p), Q = q tan p. | CO1 | 3 |
|  | d. | Write any three types of generating functions. | CO1 | 3 |
|  | e. | Prove that the Hamiltonian of a harmonic oscillator.  H = (p12 + p22)/2 + ω2(x12 + x22)/2,  with the help of the generating function  reduces to the form . | CO1 | 9 |
| (OR) | | | | |
| 6. | a. | To study the planar motion near the equilibrium points, expand the force function Ω up to second-order terms around a Lagrangian point.  Find the linearized variational equation of motion in two dimensions | CO2 | 8 |
|  | b. | Find the second-order derivatives at the collinear points and the fourth-degree characteristic equation at these points. | CO2 | 8 |
|  | c. | Prove that two roots of the characteristic equationare real and other two are pure imaginary at these points. | CO2 | 4 |
|  |  |  |  |  |
| 7. | a. | prove that the second-order derivatives at the equilateral point L4 are Ωxx= 3/4, Ωxy = 3.31/2 (μ - 1/2)/2, Ωyy = 9/4.  Using these values of partial derivatives, prove that the characteristic equation is λ4 + λ2 + 27μ (1 - μ)/4 = 0. | CO2 | 10 |
|  | b. | Find the value of the critical massμ0 at the triangular equilibrium points. Prove that all the 4 roots are pure imaginary at the triangular pointsμ0. | CO2 | 6 |
|  | c. | Construct the principal system of co-ordinates at the equilateral point L4 to show the angle α, which the major-axis of the elliptic orbit makes with the ξ-axis for mass ratio μ = 0.15 in the restricted three-body problem. | CO2 | 4 |
| (OR) | | | | |
| 8. | a. | Explain periodic and quasi-periodic orbits. | CO2 | 4 |
|  | b. | Derive Tisserand criterion for the identification of comets. | CO2 | 8 |
|  | c. | Derive the ten integrals of n-body problem. | CO2 | 8 |
|  | |  |  |  |
|  | | **Compulsory:** |  |  |
| 9. |  | Derive the equations of motion for the planar restricted three-body problem in synodic (rotating) coordinate system along with the Jacobian integral. Write the two equations to find the locations of the five equilibrium points. Derive the fifth-degree algebraic equations to find the locationsof the three collinear Lagrangian points Li (i=1, 2, 3). | CO2 | 20 |

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