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**UNIVERSITY**

(Karunya Institute of Technology & Sciences)

(Declared as Deemed-to-be University under Sec.3 of the UGC Act, 1956)

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

**End Semester Examination – Nov/Dec - 2016**

**Subject Title: ADVANCED SPACE DYNAMICS Time: 3 hours**

**Subject Code: 13AE214 MaximumMarks: 100**

**Answer ALL questions**

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| Q. No | **Question**  **PART-A (10 x 1 = 10 MARKS)** | | Marks Allotted |
| 1 | Kepler’s equation for elliptic motion is M =E - \_\_\_\_\_\_\_\_. | | 1 |
| 2 | The radial distance r for an elliptic orbit in terms of semi-major axis (a), eccentricity(e) and eccentric anomaly (E) is r = a(1 - \_\_\_\_\_\_\_ ) . | | 1 |
| 3 | The mass ratio (μ) in terms of the masses of the two primaries of masses m1 and m2 (m1> m2) in the restricted three-body problem is μ = m2/(\_\_\_\_\_\_ ). | | 1 |
| 4 | Regularization is defined as the removal of singularities occurring in the \_\_\_\_\_ of \_\_\_\_\_\_by properly selecting the variables. | | 1 |
| 5 | All the four roots of the fourth-degree characteristic equationare pure imaginary at the \_\_\_\_\_\_\_\_ points if the mass ratio µ is < 0.03852... | | 1 |
| 6 | At the collinear points, two roots of the fourth-degree characteristic equation arepure imaginary and the other two roots are \_\_\_\_\_. | | 1 |
| 7 | If all forces acting on a system of particles are derived from potential function V, then the system is called \_\_\_\_\_\_\_. | | 1 |
| 8 | A transformation between two sets of generalized coordinates is called a canonical transformationif it leaves the \_\_\_\_\_\_\_\_ Equations invariant. | | 1 |
| 9 | The independent variable to derive the equations of motion for \_\_\_\_\_\_ restricted three-body problem is true anomaly. | | 1 |
| 10 | In Hill’s problem, the mass of the \_\_\_\_\_\_ primary is very small. | | 1 |
|  | **PART-B (5 x 3 = 15 MARKS)** | |  |
| 11 | Find the radial distance r if a, e and true anomaly (f) are 8000 km, 0.1 and 45 degrees, respectively. | | 3 |
| 12 | Write theequations of motion for the planar restricted three-body problem in rotating coordinate system. | | 3 |
| 13 | Using the characteristic equation given in question 21 (b), prove that the value of the critical mass  μ0 = [1 - (69)1/2/9]/2 = 0.03852…. | | 3 |
| 14 | Define momenta and Hamiltonian. | | 3 |
| 15 | What are the perturbing forces which can be included in the restricted three-body problem? | | 3 |
|  | **PART-C (5 x 15 = 45 MARKS)**  (Sub Division Allowed) | |  |
| 16 | a | If two point masses are acted upon only by the mutual force of gravity between them, Find the motion of the centre of mass. | 10 |
| b | Using Kepler’s equation, find the value of the mean anomaly M in degrees if the eccentric anomaly E and and the eccentricity e are 80 degrees and 0.2, respectively. | 5 |
| (OR) | | | |
| 17 | Define Lambert’s problem. Derive Lambert theoremanalytically. | | 15 |
| 18 | Derive the equations of motion for the restricted three-body problem. Derive Jacobi integral. | | 15 |
| (OR) | | | |
| 19 | a | Explain a method to reduce a fourth-order system to third-order. | 8 |
| b | 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 = 0.2 in the restricted three-body problem. Write the expression as function of μ to obtain the angle α and using the expression calculate α and compare it with α obtained from the figure. | 7 |
| 20 | Write the two equations to find the locations of the five equilibrium points. Derive the fifth-degree algebraic equation to find out the location of any two of the three collinear Lagrangian points Li  (i=1, 2, 3). | | 15 |
| (OR) | | | |
| 21 | a | Find the locations of the equilateral points. Prove that the second-orderpartial derivatives at the equilateral point L4are  Ωxx= 3/4, Ωxy = 3.31/2 (μ - 1/2)/2, Ωyy = 9/4. | 10 |
| b | Using these values of partial derivatives, prove that the characteristicequation is  λ4 + λ2 + 27μ (1 - μ)/4 = 0. | 5 |
| 22 | a | Prove that the following transformation is canonical.  ; | 5 |
|  |  |
| b | Prove that the Hamiltonian of a harmonic oscillator  H = (p12 + p22)/2 + ω2(x12 + x22)/2,  with the help of the generating function  reducesto the form . | 10 |
| (OR) | | | |
| 23 | Define extended phase space.Consider a dynamical system with two degreesof freedom with its Hamiltonian independent of time. Consider a canonical transformation given by  W3 = - [p1f1(Q1, Q2) + p2 f2(Q1, Q2).  Use it to find the old coordinates and new momenta. In the extended 6-dimensional phase space, write the equations of motion. | | 15 |
| 24 | a | To study the motion around the equilibrium points, write the variational equations in three-dimensions in restricted three-body problem. | 8 |
| b | Define planar elliptic restricted three-body problem. Write its equations of motion. | 7 |
| (OR) | | | |
| 25 | Define Hill’s problem. Derive Hill's equations of motion in two dimensions. | | 15 |