Name:

Enrolment No:

UPES UNIVERSITY OF TOMORROW

End Semester Examination, Dec 2023

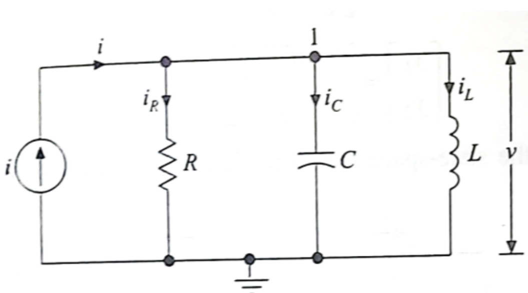
Course: Mathematical Modelling and Simulation **Semester: VII**

Program: B.Tech ASE+AVE **Time : 03 hrs.**

Course Code: AVEG 4010 **Max. Marks: 100**

Instructions: Use of graphs sheet allowed.

SECTION A
(5Qx4M=20Marks)

S. No.		**Marks**	**CO**
Q 1	Obtain a state model for the Mechanical system shown below: 	**4**	**CO1**
Q 2	The differential equation for the constrained center of gravity pitching an airplane is computed to be $\ddot{\alpha} + 2\dot{\alpha} + 25\alpha = 0$ Find the natural frequency ω_n and damping ratio ζ	**4**	**CO1**
Q 3	What are the applications of root locus method?	**4**	**CO2**
Q4	A unity feedback system is characterized by the open-loop transfer function as $G(s) = \frac{1}{s(0.5s+1)(0.2s+1)}$ Determine the steady-state errors for unit-step and unit ramp.	**4**	**CO3**
Q5	Construct state model for the following differential equation $2\dddot{y} + 3\ddot{y} + 5\dot{y} + 2y = u$	**4**	**CO4**

SECTION B (4Qx10M= 40 Marks)			
Q 6	The Dutch roll motion can be approximated using the following equations: $$\begin{bmatrix} \Delta\dot{\beta} \\ \Delta\dot{r} \end{bmatrix} = \begin{bmatrix} \frac{Y_\beta}{u_0} & -\left(1 - \frac{Y_r}{u_0}\right) \\ N_\beta & N_r \end{bmatrix} \begin{bmatrix} \Delta\beta \\ \Delta_r \end{bmatrix} + \begin{bmatrix} \frac{Y_{\delta_r}}{u_0} \\ N_{\delta_r} \end{bmatrix} \Delta\delta_r$$ Assume the coefficient in the plant matrix have the following numerical values: $Y_\beta = -7.8$ ft/s^2 $\quad N_r = -0.34$ 1/s $\quad Y_{\delta_r} = -5.236$ ft/s^2 $Y_r = 2.47$ ft/s $\quad u_0 = 154$ ft/s $\quad N_{\delta_r} = 0.616$ l/s^2 $N_\beta = 0.64$ 1/s^2 1) Determine the Dutch roll eigen values. 2) What is the damping ratio and undamped natural frequency?	**10**	**CO1**
Q 7	Draw the complete root locus for the system with $G(s) = \frac{K(s+12)}{s^2(s+20)}$.	**10**	**CO2**
Q 8	unity feedback system is characterized by the open-loop transfer function. $G(s) = \frac{1}{s(0.5s+1)(0.2s+1)}$ Determine the steady-state errors for unit-step, unit ramp and unit acceleration input.	**10**	**CO3**
Q 9	Find the state transition matrix Φ(t), the characteristic equation and the eigen value of A and Stability for the following linear time-invariant systems. $A = \begin{bmatrix} 0 & 1 \\ -3 & -2 \end{bmatrix}$, B= $\begin{bmatrix} 0 \\ 1 \end{bmatrix}$ OR $A = \begin{bmatrix} 0 & 1 \\ -1 & -1 \end{bmatrix}$, B= $\begin{bmatrix} 1 \\ 0 \end{bmatrix}$	**10**	**CO4**

SECTION-C (2Qx20M=40 Marks)			
Q 10	a) Derive the Transformation matrix from body fixed axis system into earth fixed axes system. b) A gliding parachute is flying at ψ=10 deg, θ=5 deg, and ϕ=10 deg. The on board accelerometers record a_{zb}= 1.2 m/s^2, a_{yb} = 2 m/s^2 , and a_{xb} = -2 m/s^2 . Determine the components of accelerations in earth fixed axes system.	**20**	**CO3**
Q 11	Given the second order differential equation. $\frac{dc(t)}{dx} + 2\frac{dy}{dx}$ +3c(t)=r(t) having the initial conditions c(0)=1 and dc/dt(0)=0. a) write the equation in state space form. b) Find the state transition matrix. c) Determine the solution if r(t) is a unit step function. **OR** Obtain the state transition matrix and the response of the system if the input signal is a unit step function. $\begin{bmatrix}\dot{x_1}\\ \dot{x_2}\end{bmatrix} = \begin{bmatrix}0 & 1\\ -1 & -2\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ -1\end{bmatrix}u,$ With the initial conditions $\begin{bmatrix}x_1(0)\\ x_2(0)\end{bmatrix} = \begin{bmatrix}0\\ 1\end{bmatrix},$ y=[0 1] $\begin{bmatrix}x_1\\ x_2\end{bmatrix}$	**20**	**CO4**