

Code No: **RT42022A**
**R13**
**Set No. 1**
**IV B.Tech II Semester Regular/Supplementary Examinations, April - 2018**
**ADVANCED CONTROL SYSTEMS**
**(Electrical and Electronics Engineering)**
**Time: 3 hours**
**Max. Marks: 70**
*Question paper consists of Part-A and Part-B*
*Answer ALL sub questions from Part-A*
*Answer any THREE questions from Part-B*

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**PART-A (22 Marks)**

1. a) State the significance of state transition matrix. [4]
- b) What do you mean by principle of duality? [4]
- c) Explain the effect of inherent nonlinearities on static accuracy. [4]
- d) What are the different types of stability? [3]
- e) State the fundamental theorem of the calculus of variations. [4]
- f) What is the difference between the LQR and LQG? [3]

**PART-B (3x16 = 48 Marks)**

2. a) Explain the concept of state? Write the observable canonical form? [6]
- b) The following facts are known about the linear system  $\dot{x}(t) = Ax(t)$   
 If  $x(0) = \begin{bmatrix} 1 \\ -2 \end{bmatrix}$ , then  $x(t) = \begin{bmatrix} e^{-2t} \\ -2e^{-2t} \end{bmatrix}$   
 If  $x(0) = \begin{bmatrix} 1 \\ -1 \end{bmatrix}$ , then  $x(t) = \begin{bmatrix} e^{-t} \\ -e^{-t} \end{bmatrix}$  Find  $e^{At}$  and hence A [10]
3. a) Describe the controllability tests for continuous time systems. [6]
- b) Convert the following state model into the Jordan canonical form and there from comment on controllability and observability.  

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -4 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 1 & 0 \\ 0 & 1 \\ -1 & 1 \end{bmatrix} u(t), \quad y(t) = \begin{bmatrix} 0 & 1 & -1 \\ 1 & 2 & 1 \end{bmatrix} x(t)$$
 [10]
4. a) Draw a phase plane portrait of the following system,  $\ddot{\theta} + \dot{\theta} + \sin\theta = 0$ . [8]
- b) Determine the describing function for the nonlinear element described by  $y = x^3$  where x=input to the nonlinear element (Sinusoidal signal) y=output of the nonlinear element. [8]
5. a) State and explain the Lyapunovs instability theorem. [7]
- b) Find a Lyapunovs function for the following system  

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 1 \\ 2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$
 [9]
6. a) With suitable diagrams illustrate the one point is fixed end, terminal time  $t_f$  is specified and  $x(t_f)$  free end problem and derive the necessary conditions of variational calculus. [8]
- b) Find the extremals for the functional  
 $J(x) = \int_0^1 [x^2(t) + \dot{x}^2(t)] dt; \quad x(0) = 0, x(1) = 1$  [8]
7. How LQG frame work can be used to design optimal controller? Explain with mathematical equations. [16]