Paper Code: MEE-102	Roll No.										

M. Tech.

(SEM I) ODD SEMESTER EXAMINATION 2015-16
Advanced Control System

[Time: 3 hrs.] **[Max. Marks: 100]**

Note: Attempt all questions. Different parts of the same question should be attempted together.

1. Attempt any four parts:- **(5 x4 = 20)**

a. Determine (i) eigenvalues (ii) eigenvectors of a dynamic system governed by :

$$x' = Ax + Bu$$

Where $A=\begin{bmatrix}0 & 0 & 1\\ 2 & 0 & 0\\ 8 & 2 & -5\end{bmatrix}$

b. Compare advanced control system with conventional control system.

c. The transfer function of a control system is given by

$$\frac{C(s)}{R(s)} = \frac{6(S+2)}{S(S+4)(S+3)}$$

Draw the state diagram and obtain the state equation.

d. Discuss the circle criterion.

e. Define state, state variable, state vector, state space and state equations.

f. Explain the terms (i) Positive definiteness (ii) Semi definiteness (iii) Indefinite

2. Attempt any Two parts:- **(10 x 2 = 20)**

a. Derive from fundamentals the state equation of nth order system.

b. Obtain the modal matrix from

$$A = \begin{bmatrix}0 & 1 & 0\\ 3 & 0 & 2\\ -12 & -7 & -6\end{bmatrix}$$

c. Obtain the state equation of an armature controlled separately excited dc shunt motor.

3. Attempt any TWO parts: - **(10 x 2 = 20)**

a. What is state transition matrix? List out the properties of state transition matrix and advantages of state transition matrix.

b. A linear time-invariant system is characterized by

$$\begin{bmatrix}x_1'\\ x_2'\end{bmatrix} = \begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

Determine x(t) assuming x(o)=$\begin{bmatrix}1\\0\end{bmatrix}$

c. Determine whether the system is completely controllable and completely observable or not.

$$x' = \begin{bmatrix}0 & 1 & 0\\0 & 0 & 1\\0 & -2 & -3\end{bmatrix}x + \begin{bmatrix}0\\0\\1\end{bmatrix}u,\ \ y = [3 \quad 4 \quad 1]x$$

4. Attempt any TWO parts: - (10 x 2 = 20)

a. What are inherent nonlinearities ?Sketch the following nonlinearities (i) ideal relay (ii) relay with dead zone (iii) relay with dead zone and hysteresis (iv)dead zone .

a. What are limit cycles? Explain the limit cycle behaviour of nonlinear system by considering suitable differential equation..

b. Draw the phase trajectory for linear system having the following state equations

$$x_1' = x_2 \text{ and } x_2' = x_1 + x_2 .$$

5. Attempt any two parts: - (10 x2 =20)

a. Derive the expression of describing function of a relay having dead zone and hysteresis.

b. Determine the stability of the system describe by $x' = Ax$ where

$$\begin{bmatrix}0 & 1\\-2 & -3\end{bmatrix}$$

By Lyapunov's theorem and determine a suitable Lyapunov's function.

c. Write the following (i) Statement of Lure Problem (ii) Popov Criterion.