[06 – 4124]

IV / IV B.E. DEGREE EXAMINATION.

First Semester

Electrical and Electronics Engineering

Elective : ADVANCED CONTROL SYSTEMS

(Effective from the admitted batch of 2006–2007)

Time : Three hours — Maximum : 70 marks

First question is compulsory.

Answer any FOUR from the remaining.

All questions carry equal marks.

1. (a) What is Null position in synchro? What are the applications of synchro?

   (b) What is the function of Amlidyne. Explain its characteristics and give one application.

   (c) What are the conditions to be satisfied for state controllability and observability?

   (d) List the properties of State Transition Matrix (STM).

   (e) Give the frequency domain specifications.

   (f) Write briefly on pole placement by state feedback.

   (g) When is lead compensation preferred over lag compensation? Give reasons.

7. (a) Explain the procedure for the design of phase-lead compensator using Root locus method.

(b) A unity feedback system has an open loop transfer function G(s) given by $G(s) = \frac{k}{s(s+1)}$.

Design a lead compensator for the system to meet the following specifications :

Damping ratio = 0.7; Settling time = 1.4 seconds and velocity error constant K_v = 2 $(\text{seconds})^{-1}$.

8. Write short notes on the following :

(a) Metadyne operation and characteristics.

(b) State model for linear continuous time systems.

(c) Cascade compensation in time domain.

2. (a) Give the block diagram and hence the transfer function of armature and field controlled d.c. servo motor.

(b) Explain the principle of operation of stepper motor and give its application in control systems.

3. (a) Describe the construction, explain the principle of operation and give its applications of magnetic amplifier.

(b) Explain how a synchro can be used as a position error detector.

4. (a) Find the state transition matrix of a system whose plant matrix is given by

$$A = \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}.$$

(b) A system is represented by $\dot{X} = \begin{bmatrix} -3 & -2 \\ 1 & 0 \end{bmatrix} X + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u$ with $X(0) = 0$

$Y = [0 \quad 1] X$.

Find :

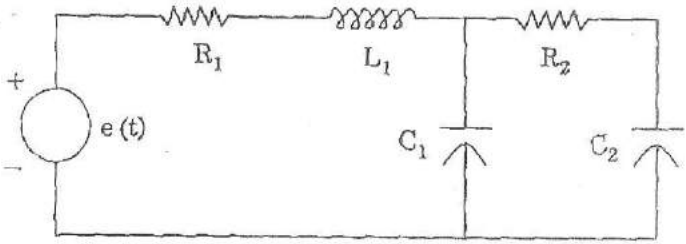
(i) the damping ratio of the system

(ii) the natural frequency of the system

(iii) the percentage overshoot for $u(t) = 1.0$ and

(iv) $y(t)$ for all $t \geq 0$.

5. (a) Obtain the state variable model for the system given below.



(b) Find the observability of the system given below.

$$\begin{bmatrix} \dot{X}_1 \\ \dot{X}_2 \\ \dot{X}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ X_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix} u$$

6. (a) What are the situations calling for compensation in a feedback control system? Enumerate them in detail with examples.

(b) Design a phase-lag network for the unity feedback control system whose open loop transfer function is given by $\frac{k}{s(1+0.2s)^2}$ to meet the following specifications.

(i) $K_v = 23 \sec^{-1}$

(ii) Phase margin $\geq 45°$.