D 26546 **(Pages : 3)** Name..............................

Reg. No..............................

JYOTHI ENGG. COLLEGE LIBRARY
THRISSUR EDUCATIONAL TRUST
CHERUTHURUTHY

SEVENTH SEMESTER B.TECH. (ENGINEERING) DEGREE EXAMINATION, DECEMBER 2006

EE 2K 703/PTEE 2K 701—CONTROL SYSTEMS—II

Time : Three Hours Maximum : 100 Marks

Answer **all** *questions.*

I. (a) Draw the circuit diagram for log compensator using RC network and obtain its transfer function.

(b) Show that a lead compensator is nothing but a PD controller with a filter.

(c) Describe design procedure for lead compensator using Bode plot technique.

(d) What is inherent non-linearities ? Give the effect of inherent non-linearities on static accuracy.

(e) Describe the isocline method of constructing phase-plane trajectories.

(f) Show that the following quadratic form is positive definite :

$$Q = 10x_1^2 + 4x_2^2 + x_3^2 + 2x_1x_2 - 2x_2x_3 - 4x_1x_3$$

(g) What is controllability ? Give condition for complete controllability.

(h) Write short notes on pole placement technique.

(8 × 5 = 40 marks)

II. (a) The forward path transfer function of a certain unity negative feedback control system is

$G(s) = \dfrac{k}{s(s^2 + 8s + 17)}$. The system has to have percentage overshoot for unit step input ≤ 16 % and steady state error for unit input ≤ 0.25 rad./sec. Design a lag compensator using root locus.

Or

(b) An uncompensated control system with unity feedback has a plant transfer function

$G(s) = \dfrac{k}{s(1 + 0.1s)(1 + 0.2s)}$. The system must satisfy the following performance specifications :

(i) The magnitude of the steady-state error of the system due to a unit ramp function input is 0.01.

(ii) Phase margin ≥ 40°. Use two identical cascaded lead compensators to compensate the system. Justify the use of two stage lead compensator.

(15 marks)

Turn over

III. (a) Obtain the describing function for the ON-OFF nonlinearity with dead zone shown in Fig. 1 below :

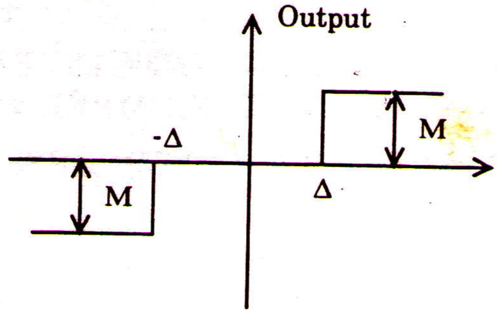

Fig. 1

(15 marks)

Or

(b) Determine the amplitude and frequency of the limit cycle of the system show in Fig. 2.

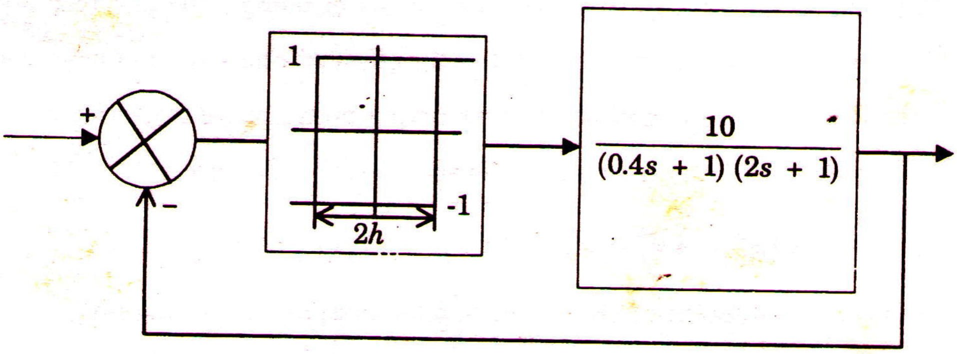

Fig. 2

(15 marks)

IV. (a) Describe asymptotic stability, in the large and instability of a system. Also give the graphical representation of stability, asymptotic stability and instability.

(15 marks)

Or

(b) Consider the system described by $\dot{x}_1 = x_2 - x_1\left(x_1^2 + x_2^2\right)$; $\dot{x}_2 = -x_1 - x_2\left(x_1^2 + x_2^2\right)$. Th origin ($x_1 = 0, x_2 = 0$) is the only equilibrium state. Determine its stability.

V. (a) Check whether the following systems are completely controllable or not :—

(i) $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} -3 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 2 & 1 \end{bmatrix} u(t).$$

(ii) $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ 0 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \end{bmatrix} u.$$

(10 + 5 = 15 marks)

Or

(b) **Check whether the following systems are completely observable or not :—**

(i) $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} u(t) \; ; \; y = \begin{bmatrix} 4 & 5 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}.$$

(ii) $$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} -1 & 0 \\ 0 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t) \; ; \; y = \begin{bmatrix} 1 & 3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}.$$

(10 + 5 = 15 marks)

[4 × 15 = 60 marks]