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RM-7111

B. E. III (Sem. VI) (Electrical) Examination

May / June – 2010

Control System - II

Time : **3** Hours] [Total Marks : **100**

Instruction :

(1)

નીચે દર્શાવેલ ☛ નિશાનીવાળી વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fillup strictly the details of ☛ signs on your answer book.

Name of the Examination :

☛ **B. E. 3 (Sem. 6) (Electrical)**

Name of the Subject :

☛ **Control System - 2**

☛ Subject Code No. : **7 1 1 1** ☛ Section No. (1, 2,.....) : **1&2**

Seat No. :

Student's Signature

(2) Write the answers to each section in **separate** answer sheet.
(3) Figures to the **right** indicate full marks.
(4) Assume suitable data wherever **necessary**.

SECTION - I

1 (a) Attempt all the questions :

(i) The open loop transfer function of a feedback control system is $K / (s^* (s^2 + 3s + 6))$ the breakaway point of its root locus _______. **1**

(ii) The open loop transfer function of a unity feedback system is given by $K / (s^* (s + 1))$. If the value of K is such that the system is critically damped. The close loop poles of the system for that value of K are ________. **2**

(iii) Indicate the type of compensator represented by the following transfer function $G_c(s) = (s + 1)/(s + 12)$. Justify your answer. **1**

(iv) If the characteristic equation of a closed loop system is $1 + K / (s^*(s + 1)(s + 2)) = 0$, the centroid of the system is ______ and the number of asymptotes are_________. **2**

(v) In a lag compensator, the maximum lag occurs at _______ mean of the two corner frequency. **1**

(vi) Draw the passive network representation for a lag lead network. **1**

(vii) The setting time of the _______ with addition of a pole to a system. Justify your answer. **1**

(b) Consider the system, which has an unstable feedforward transfer function. $G_{(s)} = 10(s+1)/(s(s-3))$. Sketch the root-locus plot and locate the closed-loop poles. Show that, although the closed-loop poles lie on the negative real axis and the system is not oscillatory, the unit-step response curve will exhibit overshoot. **10**

2 (a) The open-loop transfer function is given by **9**

$$G(s) = \frac{1}{s(s+1)(0.5s+1)}.$$

If is desired to compensate the system so that the static velocity error constant K, is 5 sec^{-1}, the phase margin is at least 40°, and the gain margin is at least 10 dB.

(b) Write the steps for designing a lag compensator using root locus method. Support your answer with necessary figures. **7**

OR

2 (a) Consider a system with an unstable plant shown in figure 1. Using the root-locus approach, design a proportional-plus-derivative controller (that is, determine the values of K, and Td) such that the damping ratio of the closed-loop system is 0.7 and the undamped natural frequency w, is 0.5 rad/sec. **5**

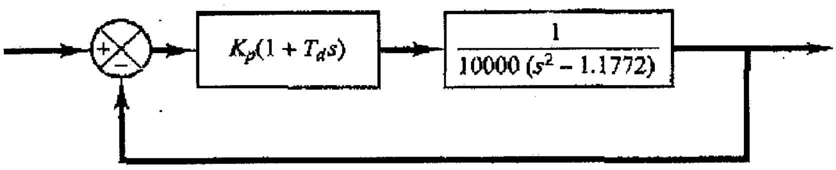

Fig. 1

(b) Explain in detail the state feedback method of design using state space analysis. **8**

3 Attempt any **two** : **14**

(a) Explain how a lead compensator improves the transient behaviour of the system.

(b) Obtain the transfer function of a PID controller. Realize the same using op-amps.

(c) Discuss the usefulness of root locus as a tool vis-a-vis bode plots for the analysis of a given control system.

SECTION - II

4 (a) Explain advantages of state variable method over conventional one. Also state limitations. **5**

(b) Define (i) positive definitiveness (ii) negative definitiveness (iii) semi positive definitiveness (iv) semi negative definitiveness (v) in definitiveness. Give example of each. **10**

(c) Show that the following function is negative definite. **5**

$$\overset{*}{x}_3 = x_2$$

$$\overset{*}{x}_2 = -x_2 - x_1^2 \; x_2.$$

5 (a) Explain procedure to achieve digitalization of matrix A. **7**

(b) For given mechanical system obtain state model in standard form. **8**

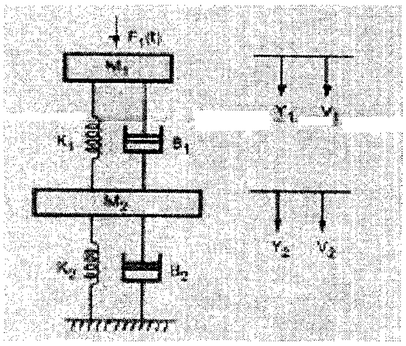

Fig. 2

OR

5 (a) Develop the state model of linear time invariant systems. **7**

(b) Obtain state model of electric system shown in figure.3 **8**

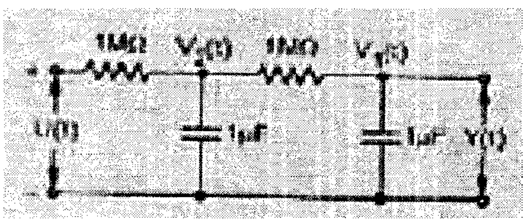

Fig. 3

OR

6 Attempt any **three** : **15**

(a) Write short note on stability in sense of liapunov.

(b) Derive the transfer function from state model.

(c) Obtain the system transfer function for a system with state model matrices given as follows :

$$A = \begin{bmatrix} -1 & 0 & 1 \\ 1 & -2 & 0 \\ 0 & 0 & 3 \end{bmatrix};\ B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix};\ C = \begin{bmatrix} 1 \\ 1 \\ 0 \end{bmatrix}^1$$

(d) Evaluate observability of the system.

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix};\ B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} \text{ and } C = \begin{bmatrix} 3 & 4 & 1 \end{bmatrix}.$$

(e) Evaluate observability of the system.

$$\begin{bmatrix} \overset{*}{X_1} \\ \overset{*}{X_2} \end{bmatrix} = \begin{bmatrix} 1 & 1 \\ -2 & -1 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} U(t) \text{ and } Y(t) = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \end{bmatrix}.$$