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SE-7423

B. E. IV (Sem. VII) Instrumentation & Control Examination

April / May – 2011

System Design

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

Instructions :

(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. 4 (Sem. 7) (Instrumentation & Control)**

Name of the Subject :

☛ **System Design**

☛Subject Code No. : **7 4 2 3** ☛Section No. (1, 2,.....) : **1, 2**

Seat No. :

Student's Signature

(2) Answer the two sections in separate answer books.
(3) Use of non programmable calculators is allowed.
(4) Assume suitable data if required.
(5) Black figures to the right indicate full marks.
(6) Draw neat diagrams and use mathematical expressions whenever required.

SECTION - I

1 (a) Determine the points where the root loci of the system G (s) with unity feedback crosses imaginary axis, where, $G(s)=\frac{K}{s(s+1)(s+2)}$. **10**

(b) What is gain margin ?

(c) How can we find the relative stability of the system using Nyquist plot ?

(d) If a fast system response is to be needed then what type of compensation is used ? Justify your answer.

(e) What do you mean by robust control ?

2 Consider the system shown in **Fig. 1**. **30**
The open-loop transfer function is given by

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

It is desired to compensate the system so that the static velocity error constant K_v, is $5\ \text{sec}^{-1}$, the phase margin is at least 40°, and the gain margin is at least 10 dB. We shall use a lag compensator of the form

$$G_c(s)=K_c\beta\frac{Ts+1}{\beta Ts+1}=K_c\frac{s+\frac{1}{T}}{s+\frac{1}{\beta T}}\quad(\beta>1).$$

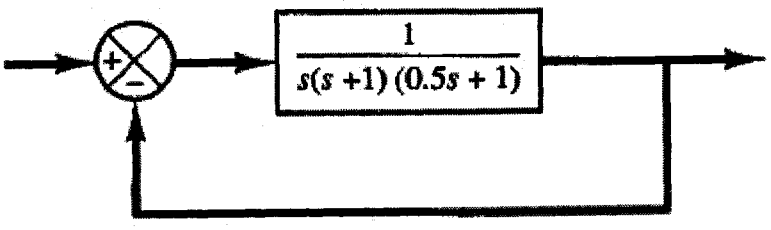

Fig. 1

Design using Bode plots.

OR

2 It is desired to compensate the system $G(s)=K/s^2$ with a unity feedback. Design a lead compensator using root locus technique to meet following specifications : Settling time less or equal 4 sec. Peak overshoot for step input less or equal 20%. **30**

3 Consider a lag-lead compensator $G_c(s)$ defined by **10**

$$G_c(s)=K_c\frac{\left(s+\frac{1}{T_1}\right)\left(s+\frac{1}{T_2}\right)}{\left(s+\frac{\beta}{T_1}\right)\left(s+\frac{1}{\beta T_2}\right)}$$

Show that at frequency ω_1, where

$$\omega_1=\frac{1}{\sqrt{T_1T_2}}$$

the phase angle of $G_c(j\omega)$ becomes zero. (This compensator acts as a lag compensator for $0 < \omega < \omega_1$ and acts as a lead compensator for $\omega_1 < \omega < \infty$)

SECTION - II

4 (a) Answer the following questions :

(i) What are the differences between network analysis and network synthesis ? **2**

(ii) Discuss Foster and Causer realization of RC impedance function. **2**

(iii) List the properties of an RL impedance with example. **2**

(iv) List the properties of a positive real function. **2**

(v) Test whether the polynomial is Hurwitz polynomial $P(s) = s^4 + s^3 + 2s^2 + 4s + 3$. **2**

(b) Obtain Causer realization (I and II) for following function : **8**

$$Z(s) = \frac{2(S+1)(S+4)}{(S+2)(S+6)}.$$

5 Synthesize the following function. Obtain all four canonical forms. **16**

$$Z(s) = \frac{(s+2)(s+5)}{(s+1)(s+3)}$$

OR

5 (a) Obtain Causer realization (I and II) for following function (RC/w) $F(s) = \frac{3(s+2)(s+4)}{s(s+3)}$. **8**

(b) Obtain Foster realization (I and II) for following function (RC N/w) $F(s) = \frac{2(s+1)(s+3)}{S(s+2)}$. **8**

6 (a) Determine the condition $a1\,b1 \geq \left(a0^{1/2} - b0^{1/2}\right)^2$ for 8

$$F(s) = \frac{s^2 + a1s + a0}{s^2 + b1s + b0}$$ to be positive.

(b) Write Strum's theorem and determine the condition for the following function : 8

$$F(s) = \frac{s + a}{s^2 + bs + c}$$ to be positive.

OR

6 (a) Test whether the following function is LC immitance or not, if so find out Causer form for it. 8

$$Z(s) = \frac{2(s+1)(s+4)}{(s+2)(s+6)}$$

(b) (i) Poles and zeros are given for a function Z(s) as 8

Poles 0, −2
Zeroes −1, −3

And $Z(\infty) = 4$. Determine $Z(s)$.

(ii) Explain causality with example.
