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RN-7423

B. E. - IV (Sem. VIII) (Instrumentation & Control) Examination

May / June – 2010

System Design

Time : Hours] [Total Marks :

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. 8) (I & C)

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 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 mathmatical expressions whenever required.

SECTION I

Q-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?

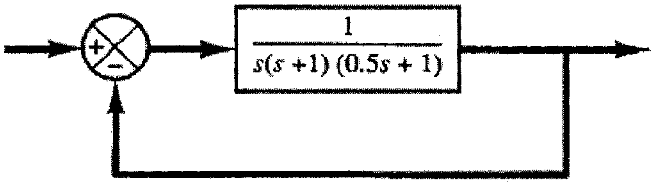
Q-2 (a) Consider the system shown in Figure 9–15. The open-loop transfer function is given by 30

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

It is desired to compensate the system so that the static velocity error constant K_v is 5 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

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



Design using Bode plots.

OR

Q-2 It is desired to compensate the system 30

(a) $G(s) = K / s(s+1)(s+4)$ with a unity feedback. Design a lag compensator using root locus technique to meet following specifications:
Settling time less or equal 10 sec
Damping ratio = 0.5
Velocity error constant = > 5 sec^{-1}

Q-3 10

Consider a lag–lead compensator $G_c(s)$ defined by

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

Show that at frequency ω_1, where

$$\omega_1 = \frac{1}{\sqrt{T_1 T_2}}$$

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

Q4 **(a)** Answer the following questions

(i) List the properties of a Hurwitz polynomial 2

(ii) Bring out the proprieties of RC impedance and admitance function 2

(iii) Check Whether $F(s) = 2s^2 + 3s + 36/s^2 + 3s + 25$ is positive real? 2

(iv) What are the properties of the positive Real Function 2

(v) Test whether the polynomial is Hurwitz polynomial 2
$P(s) = S^4 + 7s^3 + 6s^2 + 21s + 9$

(b) Obtain foster realization (I and II) for following function 8

$$Z(s) = \frac{s(s^2+10)}{(s^2+4)(s^2+16)}$$

Q5 **(a)** Synthesize the following function. Obtain all four canonical forms for following LC driving point impedance. 16

$$Z(s) = \frac{(s^2+2)(s^2+4)}{S(s^2+3)(s^2+5)}$$

OR

(b) Obtain Causer realization (I and II) for following function (RL N/w) 8

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

(b) Obtain foster realization (I and II) for following function (RC N/w) 8

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

Q6 (a) Determine the condition $a1b1 \geq (a0^{1/2} - b0^{1/2})^2$ for 8

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

(b) Write strum's theorem and give properties for the function to be positive and real. 8

OR

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

$$Z(s) = \frac{2(s^2+9)(s^2+1)}{S(s^2+4)}$$

(b) Check whether the following functions are RC function or not. Give the explanation. 8

(i) $\frac{5(s^2+1)(s^2+5)}{(s^2+4)(s^2+8)}$

(ii) $\frac{S^4+4s^2+4}{S^5+3s^3+2s}$

(iii) $\frac{(s^2+1)(s^2+6)}{S(s^2+4)}$

(iv) $\frac{3(s+1)(s+4)}{(s+3)}$
