CS/B.Tech (EE-NEW)/SEM-5/EE-503/2013-14
2013
CONTROL SYSTEM – I

Time Allotted : 3 Hours | *Full Marks* : 70

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

GROUP – A

(Multiple Choice Type Questions)

1. Choose the correct alternatives for any *ten* of the following : $10 \times 1 = 10$

i) The open loop transfer function of a unity feedback control system is $G(s)\,H(s) = \dfrac{30}{s(s+1)(s+T)}$, where T is a variable parameter. The closed-loop system will be stable for all values of

a) $T > 0$

b) $0 < T < 3$

c) $T > 5$

d) $3 < T < 5$

ii) Which of the following effects are correct in respect of addition of a pole to the open loop transfer function ?

I) The root locus is pulled to the right

II) The system becomes more oscillatory

III) The system stability relatively reduces

IV) The range gain for stability reduces.

Of these statements :

a) I and II are correct b) I and IV are correct

c) I, II and IV are correct d) All are correct.

iii) The Nyquist plot cuts the negative real axis at a distance of 0·4, then the gain margin of the system is

a) 0·4 b) – 0·4

c) 4· d) 2·5.

iv) Signal flow graph is

a) Topological representation of a set of differential equations

b) Bode plot

c) Polar plot

d) Locus of root.

v) In torque-current analogy, displacement is analogous to

a) flux b) moment of inertia

c) voltage d) current.

vi) The characteristic equation of a system is $S^2 + 2S + 2 = 0$, the system is

a) critically damped b) underdamped

c) overdamped d) none of these.

vii) Addition of a zero to the second order closed loop transfer function

a) improves the transient response characteristics

b) increase effective damping

c) decrease peak overshoot

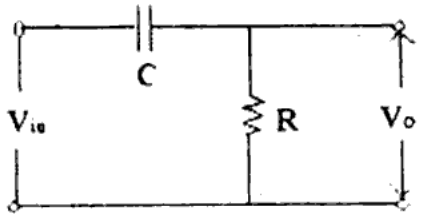
d) all of these.

viii) The condition for stability of a closed loop system with characteristic equation $S^3 + BS^2 + CS + 1 = 0$. the positive coefficient is

a) $B + C > 1$ b) $BC > 1$

c) $B = C$ d) $B > C$.

ix) The transfer function of the network given below is.



a) $\frac{1}{1 + sRC}$ b) $\frac{sRC}{1 + sRC}$

c) $\frac{RC}{1 + sRC}$ d) $\frac{1 + sRC}{1 + sRC}$.

x) Signal flow graph is used to obtain the,

a) stability a system

b) transfer function of a system

c) controllability of a system

d) observability of a system.

xi) The location of the closed loop conjugate poles of pol on $j\omega$ axis indicates that the system is

a) absolutely stable b) conditionally stable

c) marginally stable d) unstable.

xii) The function $\frac{1}{1 + sT}$ has a slope of

a) – 6 dB/decade b) 6 dB/decade

c) – 20 dB/decade d) 20 dB/decade.

xiii) The transfer function of a basic PD controller is given by (all K's are real constants)

a) $K_0 + \frac{K_1}{S} + K_2 S$ b) $K_0 + K_2 S$

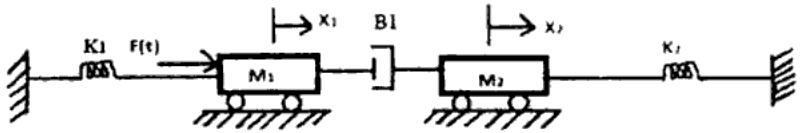
c) $K_1 S + K_2 S$ d) $K_0 + \frac{K_1}{S}$.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following. 3 × 5 = 15

2. Obtain the differential equation of mechanical system show in following figure. Draw the electrical analogous circuit based on force-current analogy.

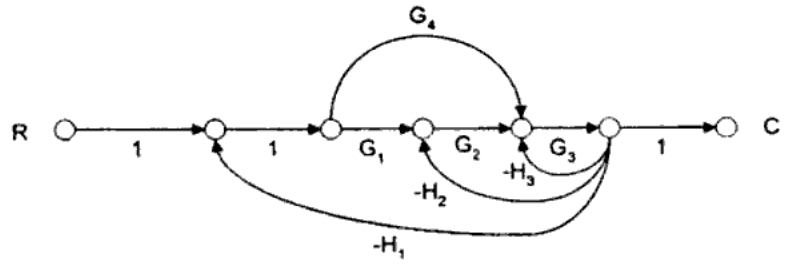


3. The overall transfer function of a unity feedback system is given by

$C(s)/R(s) = 10/s^2 + 6s + 10.$

Find the values of the static error constants. Also determine the steady state error for input $r(t) = 1 + t + t^2/2$.

4. Find out the overall transfer function C/R of the following system using the rules of Signal Flow Graph.



5. A unity feedback system has

$G(s) = \frac{180}{s(s+6)}$ & $r(t) = 4t$.

Determine,

i) the steady state error

ii) the value of K to reduce the error by 6%.

6. The characteristic equation of a system is given by $s^3 + 3ks^2 + (k+2)s + 4 = 0$. Find the range of k for which the system is stable.

7. Sketch polar plot for the unity feedback system with open loop transfer function $G(s) = \frac{1}{s(s+2)}$.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. 3 × 15 = 45

8. a) Sketch the Bode plot of a unity negative feedback closed loop system of which open loop transfer function is given by $\frac{5(s+2)}{s(s+3)(s+10)}$.

Determine gain margin, phase margin, gain cross-over frequency & phase cross-over frequency.

b) Comment on the stability of the system. 8 + 5 + 2

9. Sketch the root locus for $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$.

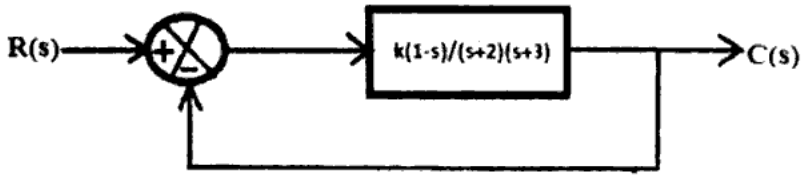
Evaluate the value of K at the point where the root loci crosses the imaginary axis. Also determine the frequency at this point. Determine the value of K such that the dominant pair of complex poles of the system has a damping ratio of 0·5.

10. a) State the Nyquist stability criterion.

b) How is Nyquist criterion different from R-H criterion ?

c) For the system shown in figure below, sketch the Nyquist plot for $k = 2$ & comment for the stability of the system using Nyquist stability criterion.

Also find the range of k for the system to be stable.



3 + 2 + 10

11. a) Find out the overall transfer function of an armature controlled *d.c.* servo portion control system.

b) Sketch the bode plot and determine the GCF and PCF of the following $G(S) = \dfrac{10}{S\,(1 + 0{\cdot}5S)\,(1 + 0{\cdot}1S)}$. 7 + 8

12. Write short notes on any *three* of the following : 3 × 5

a) PID controller

b) D.C. and A.C. tacho-generators

c) Synchros

d) Lag and lead compensator

e) Servomechanism.