EE-503

CONTROL SYSTEM-I

Time Allotted: 3 Hours | Full Marks: 70

The questions are of equal value.
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. Answer any *ten* questions. $10 \times 1 = 10$

(i) A system has the transfer function $\frac{(1-s)}{(1+s)}$. What is its gain at 1 rad/sec.

(A) 1 (B) 0 (C) –1 (D) 0.5

(ii) The "type" of a transfer function denotes the number of

(A) zeros at origin (B) poles at infinity (C) poles at origin (D) finite poles

(iii) Given that $G(s) = \frac{K}{s^2+(s+2)(s+3)}$ the type and order system is

(A) 3 and 3 (B) 2 and 4 (C) 3 and 1 (D) 3 and 0

(iv) The characteristic equation of a system is $s^2+2s+2=0$. The system is

(A) critically damped (B) under damped (C) over damped (D) none of these

(v) The steady state error for a type-3 system in following a unit step input is

(A) zero (B) infinity (C) one (D) none of these

(vi) The open loop transfer function of a unity feedback system is given by $G(s) = \frac{K}{s(s+1)(s+2)}$ the location of the centroid of the root locus is

(A) –1 (B) –2 (C) 0 (D) –0.5

(vii) Addition of a pole to the closed loop transfer function

(A) increases rise time (B) decreases rise time
(C) increases overshoot (D) has no effect

(viii) The frequency at which Nyquist diagram crosses the negative real axis is known as

(A) gain crossover frequency (B) phase crossover frequency
(C) natural frequency (D) breakaway point

(ix) A closed loop system is unstable if

(A) both gain margin and phase margin are negative
(B) gain margin is positive and phase margin is negative
(C) gain margin is negative and phase margin is positive
(D) both gain margin and phase margin are positive

(x) A PID controller can

(A) speed up response (B) reduce overshoot
(C) provide good tracking performance (D) all of these

(xi) The transfer function of a ZOH is given by

(A) $G_{h0}(s) = \frac{1-e^{-Ts}}{s}$ (B) $G_{h0}(s) = \frac{1-e^{-T}}{S}$

(C) $G_{h0}(s) = 1-e^{-Ts}$ (D) $G_{h0}(s) = s(1-e^{-Ts})$

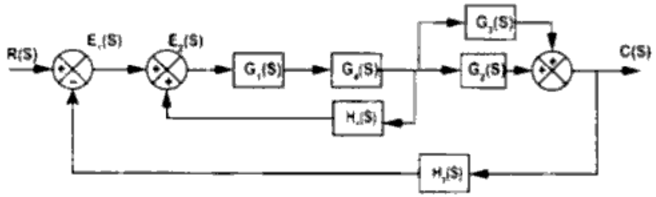
(xii) If the z-transformation of a function is $\frac{z\sin\omega T}{z^2-2z\cos\omega T+1}$. Its corresponding Laplace transform will be

(A) $\frac{s}{s^2+\omega^2}$ (B) $\frac{\omega}{s^2+\omega^2}$ (C) $\frac{1}{s^2+\omega^2}$ (D) $\frac{s+\omega}{s^2+\omega^2}$

GROUP B
(Short Answer Type Questions)

Answer any *three* questions. 3×5

2. Convert the following block diagram into its signal flow graph and find its transfer function using Mason's gain formula.



3. (a) Draw a general block diagram of a closed loop control system, describe the function of each block. 3

(b) Compare between the open loop and closed loop control systems. 2

4. State BIBO stability criterion. Show that for a bounded input-bounded output stable system $\int_0^{\infty} g(\tau)d\tau$ is finite, where $g(t)$ is the impulse response of the system. 5

5. Determine the damping ratio, undamped natural frequency, delay time, rise time, peak time and maximum overshoot for the second order system whose characteristic equation is given by $s^2 + 2.5s + 10 = 0$ 5

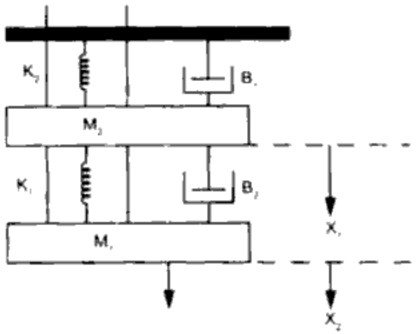
6. Using Routh's criterion determine the stability, indicating the number of roots in the right half s-plane, of a closed-loop system that has the characteristic equation $s^5 + 2s^4 + 4s^3 + 8s^2 + 16s + 32 = 0$ 5

GROUP C
(Long Answer Type Questions)

Answer any *three* questions. $3 \times 15 = 45$

7. (a) Define transfer function of a system. 3

(b) Obtain the mathematical model of the mechanical system given below. Draw the electrical analogous circuit based on force-voltage analogy. 12



HTTP://WWW.MAKAUT.COM

8. Sketch the root locus diagram as K is varied from zero to infinity for the system whose open loop transfer function is given by $G(s)H(s) = \frac{K}{s(s+6)(s^2+4s+13)}$.
Evaluate the value of K at the point where the root locus crosses the imaginary axis. Also determine the frequency at this point.

9. (a) Define gain margin and phase margin of a system.

(b) Sketch the Bode plot of a system whose open loop transfer function is given by $G(s)H(s) = \frac{4}{s(1+.5s)(1+.05s)}$ and also determine the gain margin, phase margin and the closed loop system stability.

10.(a) State the Nyquist stability criterion.

(b) Sketch the Nyquist plot of a system whose open loop transfer function is given by $G(s)H(s) = \frac{K}{s(1+s)(2+s)}$. Find the values of K for which the system becomes stable.

11. Write short notes on any *three* of the following

(a) Polar plot

(b) Potentiometer

(c) Relative stability and steady state stability

(d) Lead lag compensator

(e) Routh's stability criterion

HTTP://WWW.MAKAUT.COM