

B.E. DEGREE EXAMINATIONS: NOVEMBER 2009

Fifth Semester

U07EE503: CONTROL SYSTEMS

(Common to Aeronautical Engineering, Electrical & Electronics Engineering and Electronics & Communication Engineering Branches)

Time: Three hours

Maximum Marks: 100

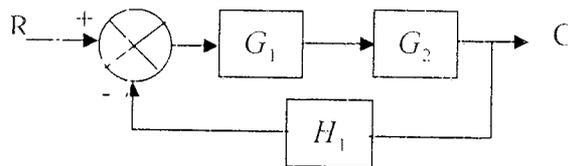
Semi log Sheets and Graph sheets need to be provided if required

Answer ALL the Questions:-

PART A (10 x 1 = 10 Marks)

- In Force-Current analogy, the Mass is analogous to _____
 (a) Capacitance (b) Inductance (c) Conductance (d) Flux Linkage

- The transfer function of the following system



- (a) $\frac{G_1 G_2}{1 + (G_1 + G_2) H_1}$ (b) $\frac{G_1 G_2}{1 + G_1 G_2 H_1}$ (c) $\frac{G_1 G_2}{1 - G_1 G_2 H_1}$ (d) $\frac{G_1 G_2 H_1}{1 + G_1 G_2 H_1}$

- The sudden shock input to a control system modeled by which of the following test signal
 (a) Step function (b) Ramp function (c) Impulse function (d) Parabolic function
- The steady state error of a type 2 system with ramp input is
 (a) Infinity (b) Zero (c) 1 (d) -1
- The relation between resonant frequency and undamped natural frequency is
 (a) $\omega_r = \omega_n \sqrt{1 - 2\zeta^2}$ (b) $\omega_n = \omega_r \sqrt{1 - 2\zeta^2}$
 (c) $\omega_r = \omega_n \sqrt{2\zeta^2 - 1}$ (d) $\omega_n = \omega_r \sqrt{2\zeta^2 - 1}$
- The centre of constant M circle is
 (a) $\left(\frac{M^2}{M^2 - 1}, 0\right)$ (b) $\left(0, \frac{M^2}{1 - M^2}\right)$ (c) $\left(\frac{M^2}{1 - M^2}, 0\right)$ (d) $\left(0, \frac{M^2}{1 - M^2}\right)$
- If the system having the complex poles on $j\omega$ -axis, the system is said to be
 (a) Stable (b) Unstable (c) Bounded Output system (d) Marginally stable

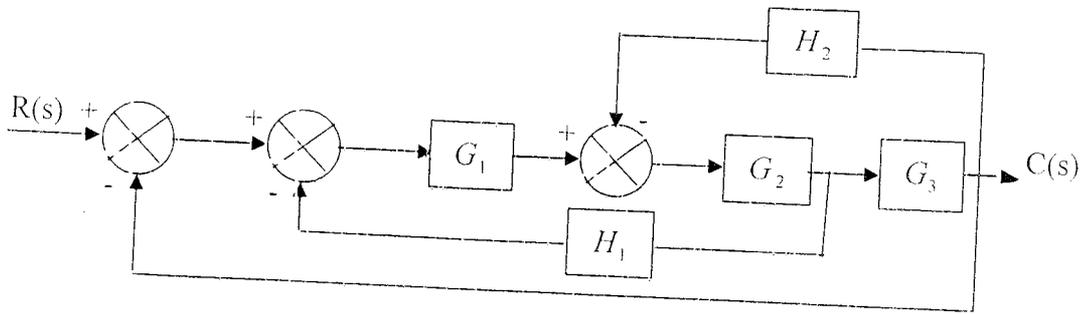
8. In terms of Bode plot, the system is stable if
- (a) Phase margin and gain margin are equal.
 - (b) Both Phase margin and gain margin are positive.
 - (c) Both Phase margin and Gain margin are negative.
 - (d) Phase margin negative but gain margin positive.
9. A lead compensator
- (a) improves the steady state accuracy
 - (b) reduces the bandwidth
 - (c) Increases the bandwidth
 - (d) reduces the speed of response
10. In lead compensator design, the frequency ω_m at which maximum phase lead occur is given by
- (a) multiplication of two corner frequencies
 - (b) square root of two corner frequencies
 - (c) root mean square of two corner frequencies
 - (d) geometric mean of two corner frequencies

PART B (10 x 2 = 20 Marks)

11. Distinguish between open loop and closed loop systems
12. State the Mason's gain formula
13. Define and write the formula for the rise time in a second order system.
14. Define PI controller and state its effects on control system.
15. Write the significance of bandwidth of a system.
16. What is a Nichol's Chart? State its uses.
17. What is the effect on stability by adding an additional pole and a zero to the left half of S-plane?
18. State Nyquist stability criterion.
19. Draw the pole-zero map of lead compensator.
20. Write the significance of lag-lead compensator.

PART C (5 x 14 = 70 Marks)

21. (a) Determine the transfer function of the system represented by the block diagram shown below using block diagram reduction technique. Also verify the result by drawing the signal flow graph.



(OR)

(b) Explain the constructional details of DC servo motor. Derive the transfer function of armature controlled DC motor and also draw the torque-speed curve.

22. (a) (i) Obtain an expression for the unit step response of a typical second order system under underdamped condition

(10)

(ii) Obtain the transfer function of PID controller.

(4)

(OR)

(b) The open loop transfer function of a servo system with unity feedback is

$G(s) = \frac{10}{s(0.1s + 1)}$. Evaluate the static error coefficients for the system. Obtain the steady state error of the system when subjected to an input given by the polynomial

$r(t) = a_0 + a_1t + \frac{a_2}{2}t^2$. Also evaluate the dynamic error using dynamic error coefficients.

23. (a) Sketch the polar plot for a unity feedback system with open loop transfer function

$G(s) = \frac{1}{s^2(1+s)(1+2s)}$. Determine the frequency at which it crosses the imaginary axis and the corresponding magnitude.

axis and the corresponding magnitude.

(OR)

(b) A unity feedback control system has $G(s) = \frac{40}{s(s+2)(s+5)}$. Draw the Bode plot.

Find gain margin and phase margin.

24. (a) (i) Determine the stability of a system based on the location of their root characteristic equation.
- (ii) The open loop transfer function of a unity feed back control system is given as $G(s) = \frac{K}{(s-2)(s+4)(s^2+6s+25)}$. Determine the value of K which will cause sustained oscillations in the closed loop system. What are the corresponding oscillation frequencies? (8)

(OR)

- (b) The forward path transfer function of a unity feedback system is given by $G(s) = \frac{K}{s(s+4)(s+5)}$. Sketch the root locus as K varies from zero to infinity.

25. (a) Draw the typical RC lag compensator network and derive the transfer function. Also explain the design procedure of lag compensator with its frequency curve.

(OR)

- (b) The open loop transfer function of a type-1 unity feedback system $G(s) = \frac{K}{s(s+1)}$

Design a lead compensator to meet the following specifications:

- (i) The phase margin of the system at least to be 45°
(ii) Velocity error constant $K_v \geq 10$
