AMIETE – ET (OLD SCHEME)

Code: AE11 **DECEMBER 2009** **Subject: CONTROL ENGINEERING**
Time: 3 Ho **Max. Marks: 100**

NOTE: There are 9 Questions in all.

- **Question 1 is compulsory and carries 20 marks. Answer to Q. 1. must be written in the space provided for it in the answer book supplied and nowhere else.**
- **Out of the remaining EIGHT Questions answer any FIVE Questions. Each question carries 16 marks.**
- **Any required data not explicitly given, may be suitably assumed and stated.**

Q.1 Choose the correct or the best alternative in the following: (2x10)

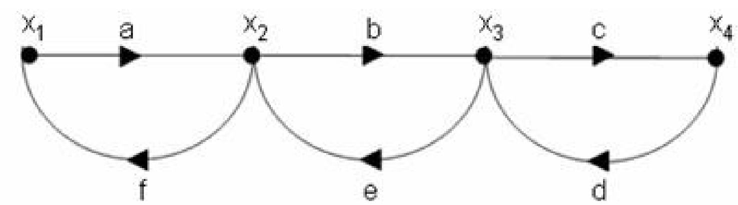
a. In a closed-loop feedback control system,

(A) input can be manipulated to obtain the desired output of the system and can also be made dependent on the actual output of the system
(B) there is no need to manipulate the input to get the desired output
(C) input doesn't depends upon the actual output of the system
(D) input can be manipulated to obtain the desired output of the system, but cannot be made dependent on the actual output of the system

b. If $F(s)=\frac{1}{s}\frac{(s+1)}{(s+k)}$ and f(t) as $t \to \infty$ is $\frac{1}{2}$, then the value of k is

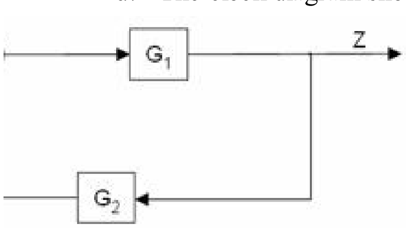
(A) $\frac{1}{2}$ **(B)** 1
(C) 2 **(D)** ∞

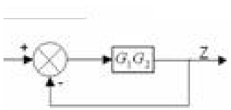
b. The sum of the gains of the feedback paths in the signal flow graph below is



(A) af + be + cd + abef + bcde + abcdef
(B) af + be + cd + abef + bcde
(C) af + be + cd + abef + abcdef
(D) af + be + cd

d. The block diagram shown in the figure is equivalent to

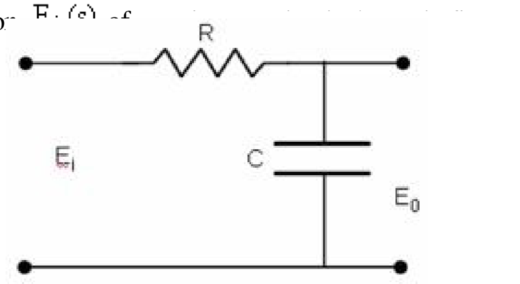




(A) **(B)**

(C) both **(A)** & **(B)** **(D)** None of these

e. The transfer functio $\frac{E_0(s)}{E_i(s)}$ of



(A) $\frac{R}{1+Cs}$

(B) $\frac{R}{RCs+1}$

(C) $\frac{1}{1+RCs}$

(D) $\frac{C}{1+Rs}$

f. Which of the following devices cannot be used as error detector?

(A) amplidyne **(B)** potentiometer

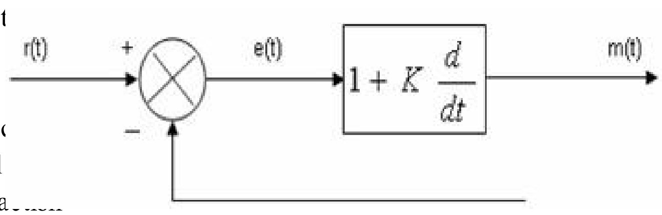
(C) synchros **(D)** LVDT

g. A first-order control system is given with transfer function as $\frac{1}{Ts+1}$. Its unit-step response for $t \geq 0$ is represented by

(A) $1-e^{-t/T}$ **(B)** $T(1-e^{-t/T})$

(C) $\frac{1}{T}e^{-t/T}$ **(D)** None of these

h. The figure depict



(A) P- control a

(B) P-D control

(C) P-I control a

(D) P-I-D control action

i. For the given open loop system determine the angles, which the asymptotes make with the real axis, $G(s)H(s) = \frac{K(s+2)}{s(s+1)(s+4)^2}$

(A) $0^0, 90^0, 180^0, 270^0$ **(B)** $60^0, 180^0, 300^0$

(C) $60^0, 150^0, 240^0, 330^0$ **(D)** $60^0, 120^0, 240^0, 300^0$

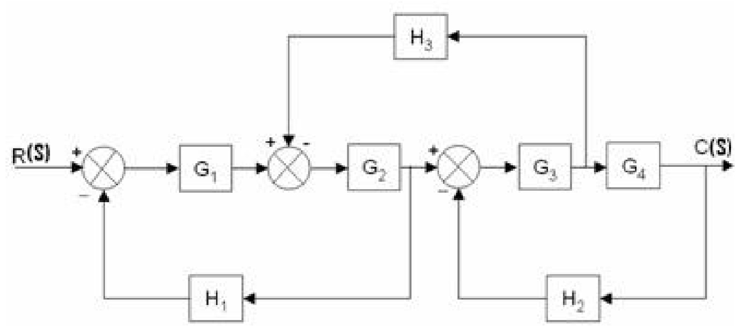
j. In reference to the frequency domain analysis of the linear control systems, the value of radius N-circles is given by

(A) $\frac{1}{2N}$ **(B)** $\sqrt{\frac{1}{4}+\frac{1}{4N^2}}$

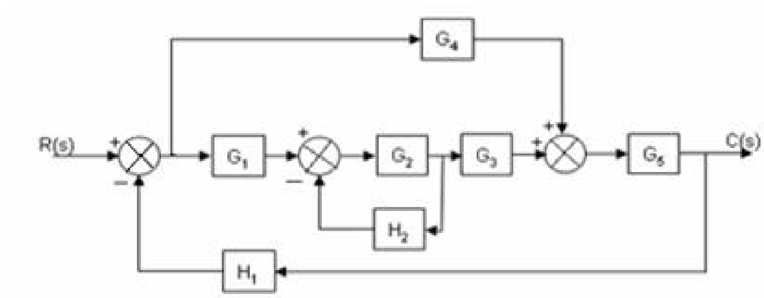
(C) $\frac{N^2}{1-N^2}$ **(D)** $\frac{N}{1-N^2}$

Answer any FIVE Questions out of EIGHT Questions.
Each question carries 16 marks.

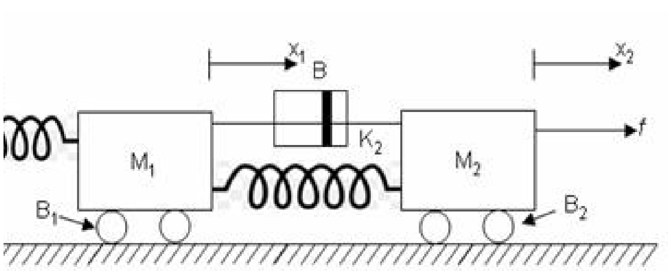
Q.2 a. Determine the closed loop transfer function of the following system using block diagram reduction technique: **(8)**



b. Develop the signal flow graph and determine the overall transfer function of the given system using Mason's Gain formula **(8)**



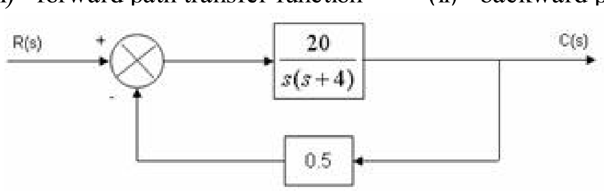
Q.3 a. Write down the differential equations describing the dynamics of the mechanical system shown in the figure below. Draw the electrical analogous of both types for the given system. K_1 and K_2 are the stiffness constants of the springs. **(8)**



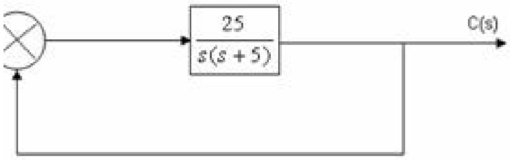
b. Explain the meaning of proportional-plus-integral control action (PI). With the help of an example, explain the function/s of a controller used in P-I control action. **(8)**

Q.4 a. For the system shown in the below figure determine the sensitivity of the closed loop transfer function for ω = 1 rad/sec with respect to

(i) forward path transfer function (ii) backward path transfer function **(8)**

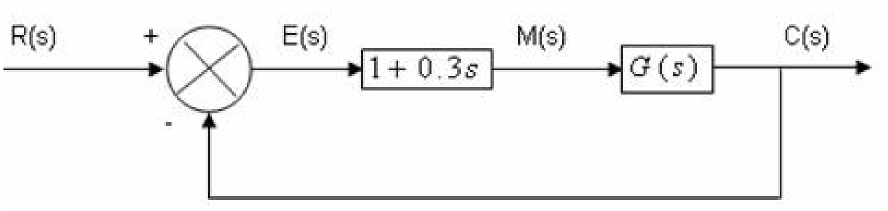


b. The figure below shows a unity feedback second-order control system. Determine (a) natural frequency of oscillations, (b) damping ratio, (c) damped frequency of oscillations, (d) rise time, (e) percentage overshoot, (f) settling time with 5% criteria time, when the system is subjected to a unit-step input. **(8)**

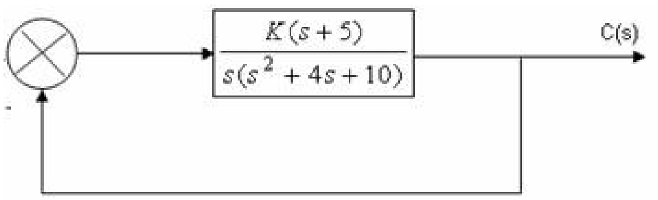


motor is used in control system applications? Give a schematic diagram, derive the transfer function and draw a block diagram for the system. **(8)**

b. A unity feedback second order control system using P-D controller has an effective damping ratio = 0.8. The transfer function of the P-D controller is (1+0.3s) and the damping ratio of the control system without P-D control is 0.2. Determine the overall transfer function of the system without P-D controller. **(8)**



Q.6 a. Using the Routh-Hurwitz criterion determine the restrictions on the value of parameter K for the system to be stable. The system is represented in figure below: **(8)**



b. Determine the position, velocity and acceleration error constants for a feedback system with the open loop transfer as $\frac{10(s+2)}{s^3(s^2+4s+100)}$. **(8)**

Q.7 a. A feedback control system has an open-loop transfer function, $G(s)H(s)=\frac{K}{s(s+2)(s+3)(s+4)}$. Find the root-locus as K is varied from 0 to ∞. **(10)**

b. Discuss using diagram, op-amp as compensation network. **(6)**

Q.8 a. Draw the asymptotic Bode plot for a system whose open-loop sinusoidal transfer function is given as $G(j\omega)H(j\omega)=\frac{10(1+j\omega)}{(j\omega)^2(1+j\omega/4-(\omega/4)^2)}$.

Determine
(i) static error coefficient (ii) gain margin
(iii) phase margin (iv) closed-loop stability **(10)**

b. Compare the following Cascade Compensator. Use diagrams where ever applicable. **(6)**
(i) Cascade Lead-Compensator, (ii) Cascade Lag-Compensator,
(iii) Cascade Lag-Lead Compensator.

Q.9 a. Using Nyquist criterion determine whether the closed-loop system having the open-loop transfer function, $G(s)H(s)=\frac{20}{s(s+4)(s-2)}$ is stable or not. **(10)**

b. Explain how you can determine the various parameters of a closed-loop system from a Nicholas Chart. **(6)**