AMIETE – ET (Current & New Scheme)

Time: 3 Hours **December - 2017** **Max. Marks: 100**

PLEASE WRITE YOUR ROLL NO. AT THE SPACE PROVIDED ON EACH PAGE IMMEDIATELY AFTER RECEIVING THE QUESTION PAPER.

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.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **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: (2×10)

a. The transfer function is defined for

(A) linear and time-variant system
(B) linear and time-invariant system
(C) non-linear and time-variant system
(D) non-linear and time-invariant system

b. For a feedback control system, the forward-path transfer function is $G(s) = \frac{K(s+3)}{s(s+1)}$ and the feedback path transfer function is H(s) = 1/s. The system is of

(A) Type0 **(B)** Type1
(C) Type2 **(D)** Type3

c. Consider the system in Fig.1 (a) and Fig. 1 (b). If the forward path gain is reduced by 10% in each system, the variation in C_1 & C_2 will be, respectively,

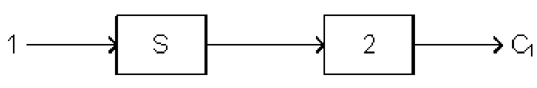


Fig.1 (a)

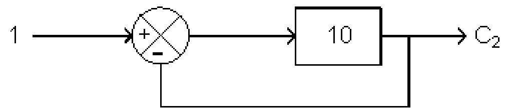


Fig. 1 (b)

(A) 10% and 10% **(B)** 2% and 10%
(C) 10% and 1% **(D)** 10% and 1%

d. The unit step response of a unity feedback system with open loop transfer function $G(s) = \frac{K}{(s+1)(s+2)}$ has a damping ratio of 0.75. The value of the gain K is

(A) 1 **(B)** 2
(C) 4 **(D)** 6

e. The first two rows of a Routh array for a third-order characteristic equation is

S^3 : 1 4
S^2 : 2 8

For the equations, there are

(A) Two roots at s = ± j4 and one root on the R-H s-plane.
(B) Two roots at s = ± j $(2)^{1/2}$ and one root on the L-H s-plane.
(C) Two roots at s = ± j2 and one root on the L-H s-plane.
(D) Two roots at s = ± j2 and one root on the R-H s-plane.

f. The root locus drawn from the transfer function $G(s)\,H(s) = K / [s(s+4)\,(s^2+4s+8)]$ crosses the imaginary axis in the s-plane when K is equal to

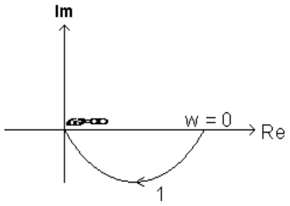
(A) 32 **(B)** 40
(C) 60 **(D)** 80

g. In a lag network, the inductor is used due to its

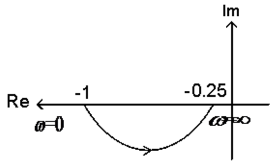
(A) High reactance **(B)** timely delay & hysteresis loss
(C) high cost **(D)** large size

h. The polar plot of $G(s) = (1+S)/(1+4S)$ for $0 \le \omega \le \infty$ in G-plane is Figure

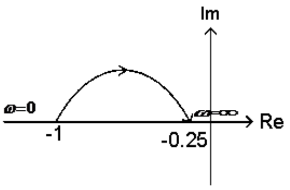
(A)



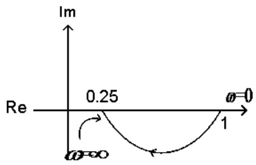
(B)



(C)



(D)



i. What will be the minimum number of states necessary to describe the network shown in Fig. 2 in a state variable form?

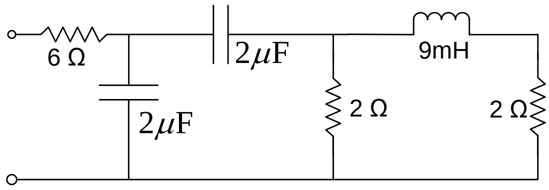


Fig.2

` **(A)** 2 **(B)** 3
(C) 4 **(D)** 6

j. If $A = \begin{bmatrix} -1 & 1 \\ 0 & -1 \end{bmatrix}$ then the state transition matrix e^{At} is

(A) $\begin{bmatrix} e^{-t} & 1 \\ 0 & e^{-t} \end{bmatrix}$ **(B)** $\begin{bmatrix} e^{-t} & 0 \\ 0 & e^{-t} \end{bmatrix}$

(C) $\begin{bmatrix} e^{-t} & te^{-t} \\ 0 & e^{-t} \end{bmatrix}$ **(D)** $\begin{bmatrix} e^{-t} & e^{-t} \\ 0 & e^{-t} \end{bmatrix}$

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

Q.2 a.Draw the force- voltage analogous network for the mechanical system shown in Fig.3. **(8)**

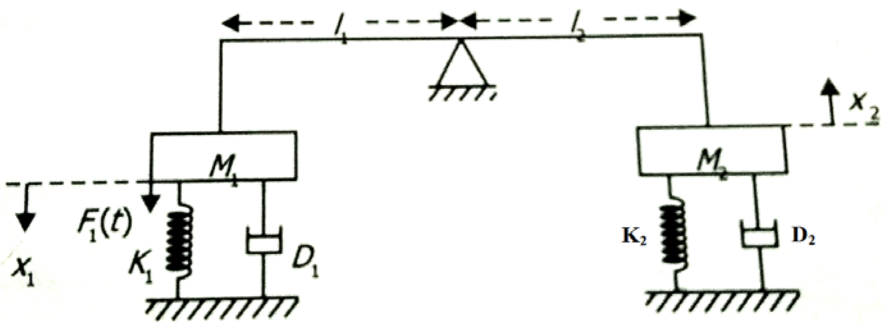


Fig. 3

b. What do you mean by servomechanism? Discuss the working of an automatic washing machine and indicate the type of control. **(8)**

Q.3 a. A dynamic system is represented by block diagram as shown in Fig.4. Draw the signal flow graph and determine the overall gain by Mason's formula. **(8)**

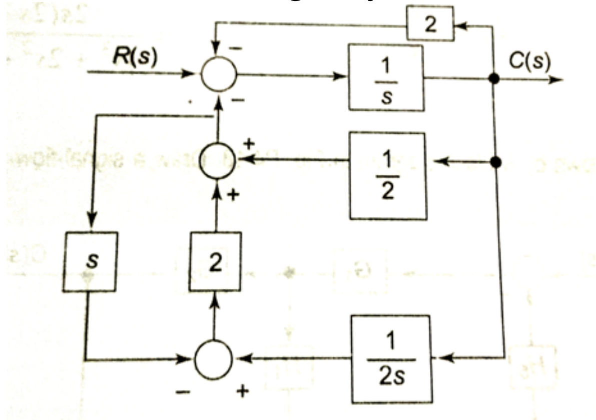


Fig. 4

b. Determine the transfer function $\frac{C(s)}{R(s)}$ from the block diagram representation shown in Fig.5. **(8)**

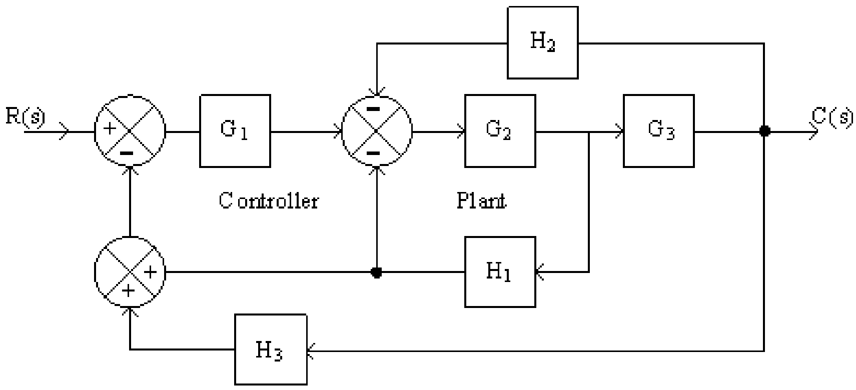


Fig. 5

Q.4 a. Define the following terms: **(2x4)**

(i) Synchros (ii) Transmitter
(iii) Synchro receiver (iv) Gyroscope

b. Consider the feedback control system shown in Fig. 6, where R_L= 10 kΩ, r_p=8kΩ, H= 0.3 and μ= 12. Find the value of 'K' for 4% system sensitivity due to variation of μ. **(8)**

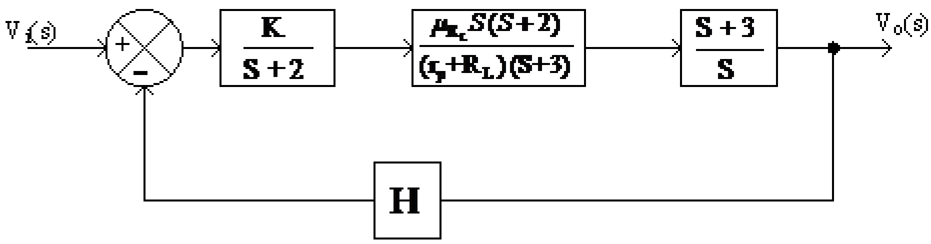


Fig. 6

Q.5 a. The open-loop transfer function of a unity feedback system is, $G(s)=\frac{8}{s(s^2+2as+a+3)}$

(i) Find the value of 'a' for which the system response is oscillatory, given 'a' is a variable positive parameter.
(ii) Find the range of 'a' for which the system is absolutely stable. **(4+4)**

b. A second order system is represented by transfer function
$$\frac{C(s)}{R(s)} = \frac{180}{s^2 + 19.6s + 196}$$
Find the value of damping ratio, natural and damped frequency of oscillation and the time constant for the decaying envelope. **(8)**

Q.6 a. Sketch the asymptotes of the root locus for $G(s)H(s) = \dfrac{k}{s(s+4)(s^2+4s+20)}$ **(8)**

b. What do you mean by gain margin and phase margin? Also state the effect of addition of poles and zeros in root locus. **(8)**

Q.7 a. An asymptotic log-magnitude plot is shown in Fig.7.Find the transfer function and gain cross-over frequency. **(8)**

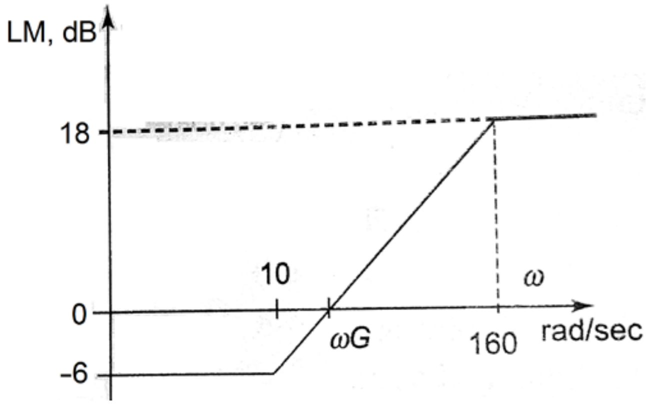


Fig.7

b. A feedback control system has a forward path transfer function
$$G(s) = \frac{10}{s(s+10)}$$
The feedback path contains a delay element with transfer function
$H(s) = e^{-Ts}$
Determine the value of T for which the system is marginally stable. **(8)**

Q.8 A negative unity feedback control system has plant transfer function $G_p(s) = \dfrac{k}{s(s+a)}$
Design a cascade compensator that maintains a peak overshoot of 16.5% but that reduces the settling time by a factor of 2. **(16)**

Q.9 a. The plant is given by $\dot{X} = AX + BU$, where $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -6 \end{bmatrix}$, $B = \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix}$.

The system uses the feedback control $\bar{U} = -\bar{K}\bar{X}$. If the desired closed loop poles at s = –2+4j, s = –2– 4j and s = –10. Determine the state feedback gain matrix K. **(8)**

b. Test the asymptotic stability using the Lyapunov second method for the system dynamics
$\dot{Y} = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix} Y$ **(8)**