AMIETE – ET (NEW SCHEME) – Code: AE61

Subject: CONTROL ENGINEERING

Time: 3 Hours **Max. Marks: 10**

DECEMBER 2010

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 half an hour 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)**

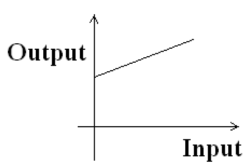
a. As compared to a closed -loop system, an open loop system is

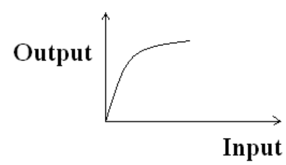
(A) more stable as well as more accurate
(B) less stable as well as less accurate
(C) more stable but less accurate
(D) less stable but more accurate

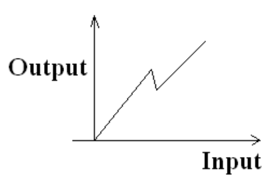
b. A linear system, initially at rest, is subjected to an input signal $r(t) = 1 - e^{-t}$ if $c(t) = 1 - e^{-2t}$ for $t \geq 0$ then transfer function of the system

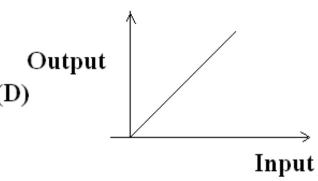
(A) $\frac{s+2}{s+1}$ **(B)** $\frac{2(s+1)}{(s+2)}$
(C) $\frac{(s+1)}{2(s+2)}$ **(D)** $\frac{2(s+2)}{(s+1)}$

c. Which one of the following input-output relation is that of a linear system

(A)


(B)


(C)


(D)


d. The system has a transfer function $\frac{\quad}{s+2}$. The gain for ω=2 rad/sec will be

(A) 0.707 **(B)** 0.667
(C) 0.5 **(D)** 0.8

e. For a unit step input, a system with forward path transfer function $G(s) = \frac{20}{s^2}$ and feedback path transfer function H(s)=s+2, has a steady state output of

(A) 20 **(B)** 5
(C) 0.2 **(D)**

f. For the signal flow graph shown in Fig. 1 below, the value of x_2 is

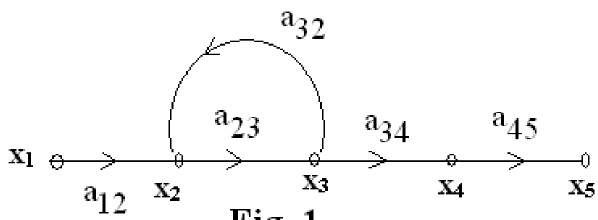


Fig. 1

(A) $a_{12} x_1$ **(B)** [illegible]
(C) $a_{12} x_1 - a_{23} x_3 + a_{32} x_3$ **(D)** $-a_{12}x_1 + a_{32}x_3$

g. While forming Routh's array, the situation of a row of zeros indicates that the system

(A) has symmetrically located roots   **(B)** is not sensitive to variations in gain
(C) is stable   **(D)** unstable

h. The root locus of unity feedback system is shown in Fig. 2. The open loop transfer function of the system is

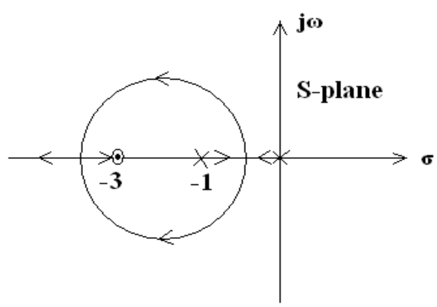


Fig. 2

(A) $\dfrac{K}{s(s+1)(s+3)}$ **(B)** $\dfrac{K(s+1)}{s(s+3)}$

(C) $\dfrac{K(s+3)}{s(s+1)}$ **(D)** $\dfrac{Ks}{(s+1)(s+3)}$

i. Non-minimum phase transfer function is defined as the transfer function which

(A) has zeros in the right-half and poles in the left half of S-plane
(B) has zeros and poles to the right half of S-plane
(C) has zeros and poles to the left half of S-plane
(D) has zeros in the left half and poles in the right half of S-plane

j. The gain margin in dB of a system having the loop transfer function

$$G(s)\,H(s) = \frac{\sqrt{2}}{s(s+1)} \text{ is}$$

(A) 0   **(B)** 3
(C) 6   **(D)** ∞

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

Q.2 a. What is the need for automatic control system? Explain the same with suitable block diagram. **(8)**

b. For the electrical network shown in Fig.3, find the transfer function $\frac{v_o(s)}{v_i(s)}$ **(8)**

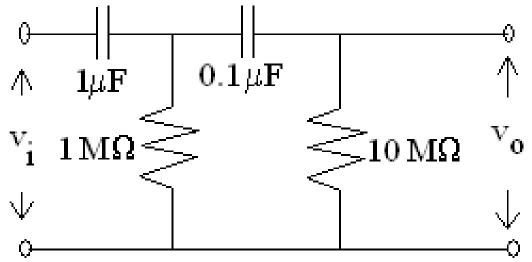


Fig.3

Q.3 a. For the block diagram shown in Fig.4, obtain the transfer function using block diagram reduction techniques. **(8)**

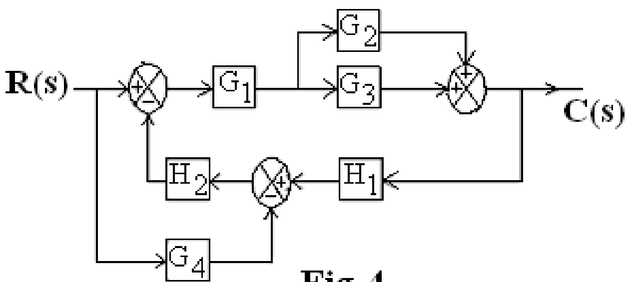


Fig.4

b. Obtain the expression for transfer function $\frac{C(s)}{R(s)}$, of the signal flow graph as shown in Fig.5. **(8)**

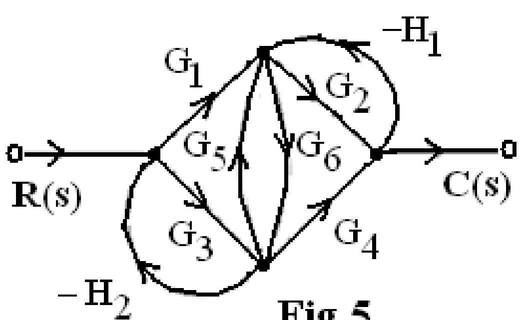


Fig.5

Q.4 a. The block diagram of an automatic control system of speed for an automobile is as shown in Fig.6. (i) find the sensitivity of closed loop system to changes in K and calculate its steady state value for K =1.5 and K_1=60 (ii) for a steady speed of 60 km/h, find R with system loop open and closed. **(9)**

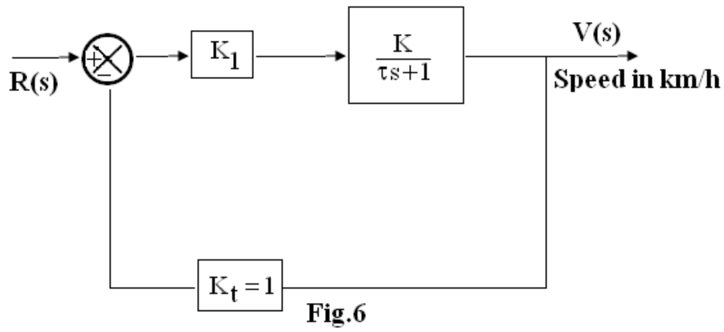


Fig.6

b. Explain different types of controller components. **(7)**

Q.5 a. A system is characterised by the transfer function $\frac{8}{s^2+(2+8a)s+8}$. Find value of 'a', if $\xi = 0.7$. Also calculate peak overshoot time at which peak overshoot occurred and settling time. **(8)**

b. Explain the effect of adding a zero to a system. **(8)**

Q.6 The open loop transfer function of a unity feedback system is

$$G(s)H(s) = \frac{K}{s(s+1)(s^2+4s+13)}$$

Plot the root loci for the system. Determine the range of gain *K* for the stability. **(16)**

Q.7 a. Using Nyquist stability criterion, discuss the stability of a unity feedback control system having the open loop transfer function given by

$$G(s) = \frac{50}{s(1+0.5s)(1+0.2\,s)}$$ **(12)**

b. Explain all-pass system **(4)**

Q.8 Consider a plant with transfer function $G(s)H(s) = \frac{4K}{s(s+2)}$. Design a suitable compensator with specifications $K_v = 20$ and phase margin at least 50°, in frequency domain. **(16)**

Q.9 a. A linear time invariant system is described by the following state model

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ -6 & -11 & -6\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 2\end{bmatrix}u$$ **(8)**

Transform this state model into a canonical state model with suitable state transition matrix M.

b. If $A = \begin{bmatrix}0 & 1 & 0\\ 0 & 0 & 1\\ 0 & -2 & -3\end{bmatrix}$, $B = \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}$ and $C = \begin{bmatrix}3 & 4 & 1\end{bmatrix}$

check whether the system is (i) completely controllable (ii) completely observable. **(8)**