ROLL NO. ___________________

**Code: AE109** **Subject: CONTROL ENGINEERING**

# AMIETE – ET *{NEW SCHEME}*

**Time: 3 Hours** **DECEMBER 2014** **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 number of forward paths and the number of pairs of non touching loops for the signal flow graph (Fig.1) are

**(A)** 1, 3
**(B)** 3, 2
**(C)** 3, 1
**(D)** 2, 4

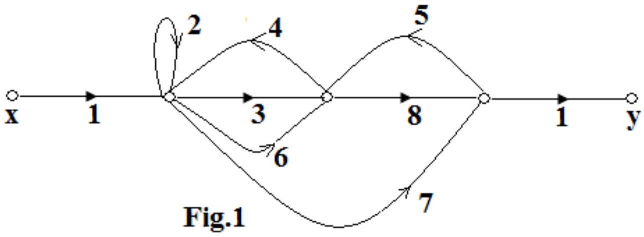

**Fig.1**

b. The effect of tachometer feedback is to reduce in a system

**(A)** Gain **(B)** Time constant
**(C)** Damping **(D)** Both gain & time constant

c. By Force-Current analogy Damping factor is analogous to

**(A)** Inductance (L) **(B)** Conductance $\left(\frac{1}{R}\right)$
**(C)** Capacitance (C) **(D)** Resistance (R)

d. Indicate type of the transfer function for the block diagram shown below in Fig.2

**(A)** Type 0
**(B)** Type 1
**(C)** Type 2
**(D)** Type 3

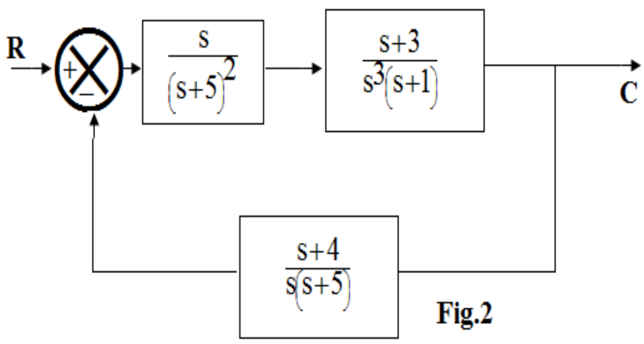

**Fig.2**

e. The sensitivity of open loop control system is

**(A)** Unity **(B)** Infinity
**(C)** Zero **(D)** None of these

f. For a second order system time for second overshoot is

(A) $\frac{\pi}{\omega_d}$ (B) $\frac{2\pi}{\omega_d}$

(C) $\frac{3\pi}{\omega_d}$ (D) $\frac{4\pi}{\omega_d}$

g. The root locus plot for unity feedback system is shown in Fig.3. The maximum possible controller gain for which system is stable is approximately

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

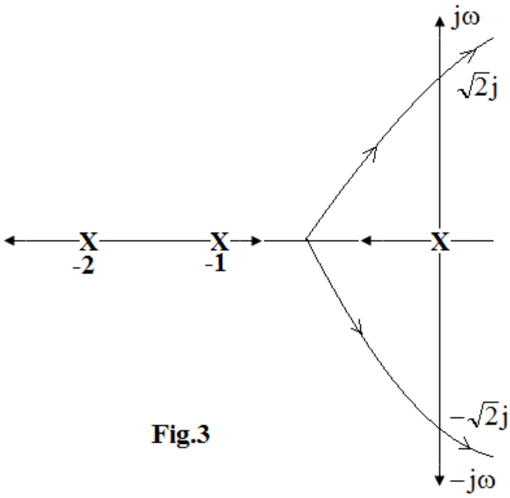


Fig.3

h. The Nyquist plot obey's the

(A) principle of argument (B) principle of superposition
(C) principle of motion (D) all of these

i. The lag comparators

(A) Increases bandwidth (B) Decreases band width
(C) Does not affect bandwidth (D) None of these

j. Which of the following is correct?

(A) $\varphi(0) = 0$ (B) $\varphi^{-1}(t) = \varphi\left(\frac{1}{t}\right)$

(C) $\varphi(t_1 + t_2) = \varphi(t_1)\varphi(t_2)$ (D) none of these

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

**Q.2** a. Compare open loop and closed loop control system. **(6)**

b. Derive transfer function of the circuit shown in Fig.4. **(6)**

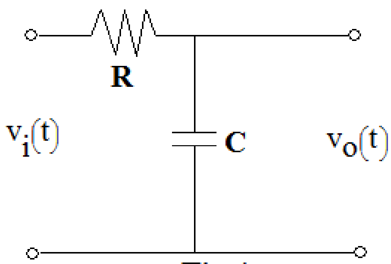


Fig.4

c. Draw electrical analogous circuit for mechanical system shown in Fig.5 based on Force-Voltage analogy. **(4)**

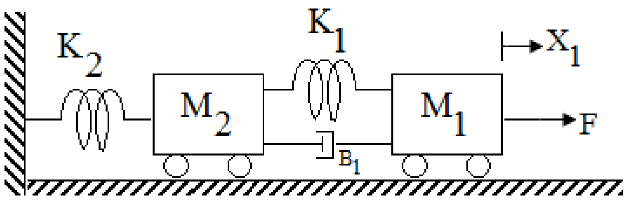


**Fig.5**

**Q.3** a. Find transfer function $\left(C/R\right)$ for the system represented in Fig.6 using block diagram reduction method. **(8)**

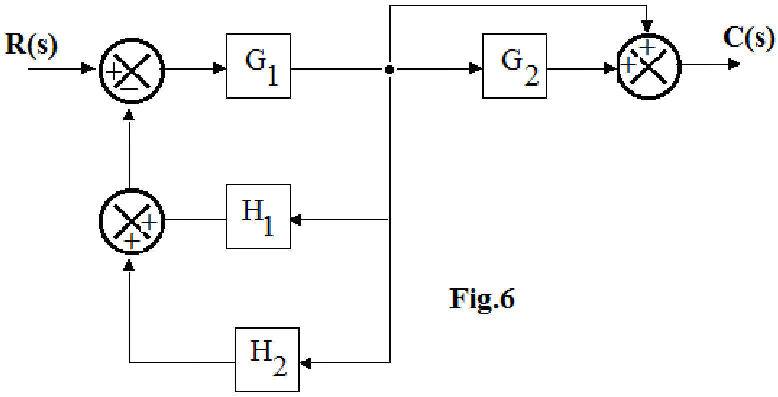


**Fig.6**

b. Find transfer function $\frac{C}{R}$ using Maison's gain formula of block diagram shown in Fig. 6. **(8)**

**Q.4** a. Explain effect of feedback on sensitivity of open loop and closed loop control systems. **(8)**

b. Find transfer function and write features of AC servomotor. **(8)**

**Q.5** a. For a unit step response of second order system, determine damping ratio for overshoot of 37% and $\omega_n$ if response takes 10 second to reach within 5% of final value. **(5)**

b. Unity feedback system has open loop T.F. $G(s)=\frac{k(1+2s)}{s(1+s)(1+4s)^2}$. Find value of k to limit steady state error to 10% when input is unit ramp. **(5)**

c. Determine value of K for stable system shown in Fig.7. **(6)**

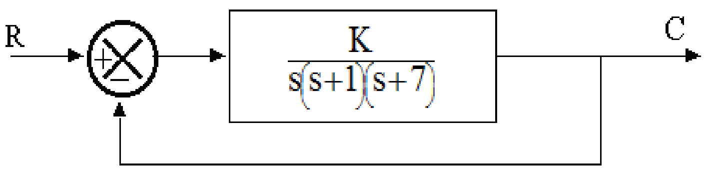


**Fig.7**

**Q.6** Draw Root locus for the system having $G(s)H(s) = \dfrac{k}{s(s+3)(s^2+3s+4.5)}$. Also comment on its stability. **(16)**

**Q.7** a. Determine $M_r$ & $W_r$ for unity feedback system with $G(s) = \dfrac{10}{s^2+2s+10}$ **(4)**

b. Draw the complete Nyquist Plot and discuss stability of a system with $G(s)H(s) = \dfrac{k}{s(s-a)}$ here a > 0 **(8)**

c. Draw polar plot of $G(s)H(s) = \dfrac{k}{s(1+s)}$. **(4)**

**Q.8** Consider unity feedback control system with the open loop transfer function $G(s) = \dfrac{k}{s^2(0.2s+1)}$. Design compensator using Bode plot to produce the following specifications $K_a = 10$ and phase margin = $35^\circ$ **(16)**

**Q.9** a. Define the following: **(4×2 = 8)**

(i) State variables
(ii) State vector
(iii) State space
(iv) State space equations

b. Obtain transfer function of system given by **(8)**

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -7 & -2 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$\& \ Y = \begin{bmatrix} 1 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$