ROLL NO. ________________

Code: AE61/AE109 **Subject: CONTROL ENGINEERING**

AMIETE – ET *{Current & New Scheme}*

Time: 3 Hours **JUNE 2016** **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 damping ratio of a system having the characteristic equation $s^2+2s+8=0$ is

(A) 0.353 **(B)** 0.330
(C) 0.300 **(D)** 0.250

b. The open loop transfer function of system is G(s) H(s)= K(s+2)/s(s+3)(s+4), its centroid is at σ_A =

(A) -2.5 **(B)** -4
(C) -4.5 **(D)** 0

c. The steady-state error of a feedback control system with an acceleration input is finite in a

(A) type 0 system **(B)** type 1 system
(C) type 2 system **(D)** type 3 system

d. The impulse response of the standard second order system can be obtained from its unit step response by

(A) integrating **(B)** differentiating
(C) inverse laplace of function **(D)** transfer function

e. The transfer function of the block diagram shown in fig.1 is :-

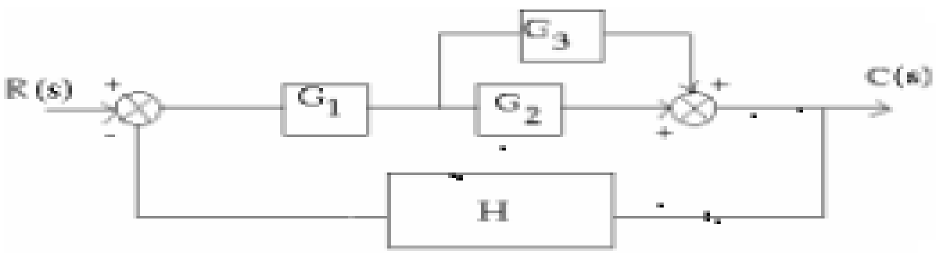

Fig. 1

(A) $\dfrac{G_2(G_1+G_3)}{1+G_1G_2H+G_1G_3H}$ **(B)** $\dfrac{G_1(G_2+G_3)}{1+G_1G_2H+G_1G_3H}$

(C) $\dfrac{G_1(G_2-G_3)}{1+G_1G_2H+G_1G_3H}$ **(D)** $\dfrac{G_1(G_2+G_3)}{1+G_1H+G_3H}$

f. For a standard second-order system described by , $s^2 + 2\zeta\omega_n s + \omega_n^2$ the term $1/\zeta\omega_n$ indicates

(A) time-constant **(B)** damping factor
(C) natural frequency **(D)** none of these

g. Lead-lag compensation is needed for

(A) transient response improvement
(B) steady state response improvement
(C) both transient and steady state response improvement
(D) none of these

h. The input to a controller is

(A) sensed signal **(B)** desired variable value
(C) error signal **(D)** servo-signal

i. If the Nyquist plot of the loop transfer function G(s) H(s) of a closed-loop system encloses the (-1, j0) point in the G(s) H(s) plane, the gain margin of the system is

(A) zero **(B)** greater than zero
(C) less than zero **(D)** infinity

j. An n x n matrix is said to be nonsingular if the rank of the matrix r is

(A) $r < n$ **(B)** r.n
(C) $r = n/2$ **(D)** 2n

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

Q.2 a. Define control system. When is a control system said to be robust? **(8)**

b. Compare open loop and closed loop system. Justify with suitable examples. **(8)**

Q.3 a. Compare with block diagram and signal flow graph, the representation of a control system. **(8)**

b. Draw the signal flow graph of the block diagram shown in Figure 2 and obtain the overall transfer function. **(8)**

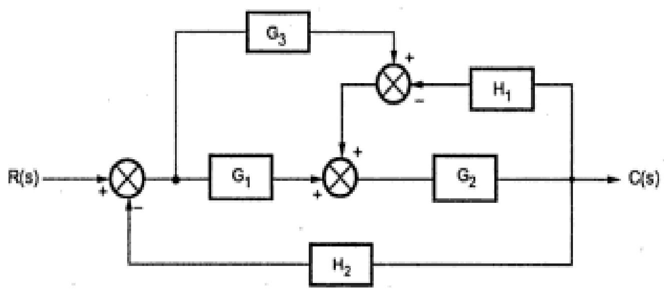

Fig. 2

Q.4 a. Explain the various types of controller components with suitable example. **(6)**

b. Define sensitivity. Discuss the sensitivity of closed loop transfer function for variation in forward path and feedback path transfer function. **(10)**

Q.5 a. The transfer functions for a single-loop non-unity-feedback control system are given as $G(s)=\frac{1}{s^2+s+2}$ and $H(s)=\frac{1}{s+1}$ **(8)**

Find the steady-state errors due to a unit-step input, a unit-ramp input and a parabolic input.

b. Determine the range of K for stability of a unity –feedback control system whose open-loop transfer function is $G(s)=\frac{K}{s(s+1)(s+2)}$ **(8)**

Q.6 Construct the root locus and comment on the stability of a unity-feedback control system having an open-loop transfer function $G(s)=\frac{K}{s(s+1)(2s+3)}$ **(16)**

Q.7 A unity-feedback system has open-loop transfer function $G(s)=\frac{4}{s(s+1)(s+2)}$

(i) Using Bode plots, determine the phase margin of the system.

(ii) How should the gain be adjusted so that phase margin becomes 50°? **(8+8)**

Q.8 Write short notes on the following: **(8+8)**

(i) Controller tuning

(ii) Phase-lead compensation

Q.9 a. Find the state transition matrix for **(8)**

$$A = \begin{bmatrix} 0 & -1 \\ +2 & -3 \end{bmatrix}$$

b. Evaluate Observability and Controllability of the following state model **(8)**

$$A=\begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & -3 \\ 0 & 1 & -4 \end{bmatrix} \quad B=\begin{bmatrix} 40 \\ 10 \\ 0 \end{bmatrix} \quad C=\begin{bmatrix} 0 & 0 & 1 \end{bmatrix}$$