ROLL NO. ___________________

Code: AE61 **Subject: CONTROL ENGINEERING**

AMIETE – ET

Time: 3 Hours **DECEMBER 2013** **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. If the system have phase margin approaching zero or its gain margin approaching unity the system will be observed as

(A) highly stable system **(B)** oscillating system
(C) relatively stable system **(D)** unstable system

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

(A) type 0 system **(B)** type 1 system
(C) type 2 system **(D)** type 4 system

c. In a control system, the Laplace transform of error e(t) is s (s +10)/ 8(s+3) then the steady state value of if error will be ______.

(A) 3.6 **(B)** 1.8
(C) 3.2 **(D)** 2.4

d. 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

e. The transfer function of the system shown in Fig.1 will be (where, $\tau = RC$)

(A) $\dfrac{1}{\tau^2 s^2 + 3\tau s + 1}$

(B) $\dfrac{1}{\tau^2 s^2 + \tau s + 1}$

(C) $\dfrac{-1}{\tau^2 s^2 + 3\tau s + 1}$

(D) None of these

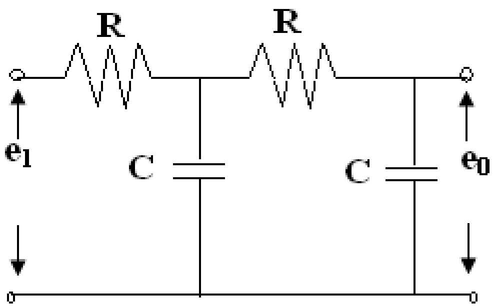

Fig.1

f. An open loop system represented by the transfer function G(s) = $\frac{(s-1)}{(s+2)(s+3)}$ is

(A) stable and of the minimum phase type
(B) stable and of the non-minimum phase type
(C) unstable and of the minimum phase type
(D) unstable and of the non-minimum phase type

g. On the Bode magnitude plot, the slope of the pole $1/(5 + j\omega)^2$ is

(A) 20 dB/decade **(B)** 40 dB/decade
(C) - 40 dB/decade **(D)** -20 dB/decade

h. Root loci will show asymptotic behaviour when

(A) there are more open loop zeros than open loop poles
(B) there are more open loop poles than open loop zero
(C) there are equal number of open loop zeros and open loop poles
(D) none of these

i. The important properties of a fundamental matrix are

(A) it is an identity matrix at r=0
(B) it satisfies the original state-space equation
(C) its inverse is equal to the fundamental matrix evaluated at negative time
(D) All of these

j. Lead compensators are slightly similar to

(A) PD controllers **(B)** PI controllers
(C) PID controllers **(D)** none of these

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

Q.2 a. What is open and closed loop control? Discuss advantages and disadvantages of each. **(8)**

b. Determine the transfer function $V_o(s)/V_i(s)$ of the electrical system given in Fig.2 **(8)**

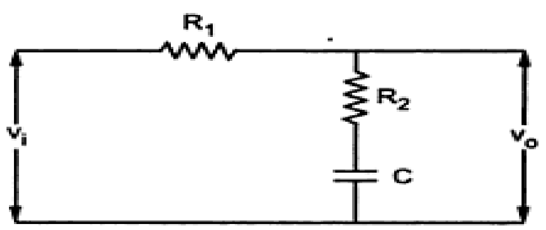

Fig.2

Q.3 Determine the transfer function C(s) /R(s) for the block diagram as shown in Fig.3 by drawing its signal flow graph and using the Mason's gain formula **(16)**

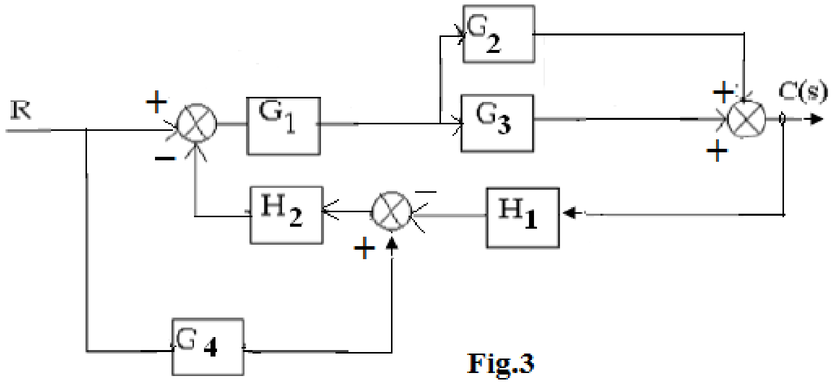

Fig.3

Q.4 a. Explain the construction and working principle of stepper motor write its applications. **(8)**

b. A unity feedback control system has the open-loop function as $\frac{5}{s(s+2)}$.

Find the response of the system considering controller transfer function as (2s + 3) and with a step input. **(8)**

Q.5 a. The open loop function of unity feedback system is given by

$$G(s) = \frac{4}{(s+1)}$$

Find the nature of response of the closed loop system for a unit step input. Also calculate rise time, peak time, peak overshoot and settling time of the system**.** **(8)**

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 Sketch the root locus diagram for a unity feedback system with its open loop function $G(s) = \frac{K(s+3)10}{s(s^2+2s+2)(s+9)(s+5)}$

Thus find the value of K at a point where the complex poles provide a damping factor of 0.5 **(16)**

Q.7 a. Obtain Bode plot for the system represented by

$$H(\omega) = \frac{j\omega + 10}{j\omega(j\omega+5)^2}$$

Also determine the Phase margin and Gain margin of the system. **(8)**

b. Draw the complete Nyquist plot for a unity feedback system having the open loop function $G(s) = \frac{6}{s(1+0.5s)(6+s)}$ from the plot evaluate absolute and relative stability of the system. **(8)**

Q.8 a. Consider the control system shown in Fig.4 below in which a proportional compensator is employed. A specification on the control system is that the steady-state error must be less than two per cent for constant inputs. Find K_C that satisfies this specification. **(8)**

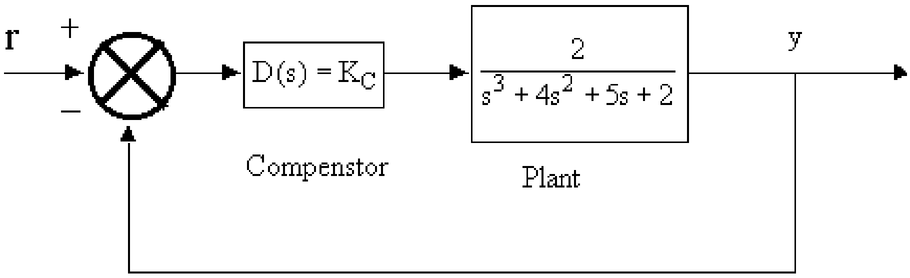

Fig.4

b. Explain a technique to obtain magnitude and phase frequency characteristics of phase lag compensator. **(8)**

Q.9 a. Obtain the transfer function of the given state equation:

$$\dot{x} = \begin{bmatrix} 0 & 1 \\ -8 & -6 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

$$y = \begin{bmatrix} 1 & 1 \end{bmatrix} x$$ **(8)**

b. Consider the linear continuous-time dynamic system represented by transfer function H (s) = (s+3)/(s+1)(s+2)(s+3). Evaluate whether the system is
(i) completely controllable
(ii) completely observable **(8)**