ROLL NO. ________________

Code: AE61 **Subject: CONTROL ENGINEERING**

AMIETE – ET

Time: 3 Hours **JUNE 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. The Laplace transform of a simple RC integrator circuit shown in Fig.1 is

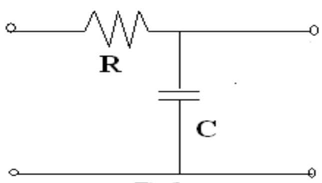

Fig.1

(A) $\frac{1}{s-a}$ **(B)** $\frac{1}{s+a}$

(C) $\frac{a}{s-a}$ **(D)** $\frac{a}{s+a}$

Where $a = \frac{1}{RC}$

b. According to initial value theorem, the initial value of $f(0^+)$ of a function f(t) is

(A) $f(0^+) = \lim_{s\to 0}[sF(s)]$ **(B)** $f(0^+) = \lim_{s\to\infty}[sF(s)]$

(C) $f(0^+) = \lim_{s\to 0}[F(s)]$ **(D)** $f(0^+) = \lim_{s\to\infty}[F(s)]$

c. If the characteristic equation of a system is $s^2+8s+25=0$, the value of ω_n and ξ will be

(A) 5 rad/sec, 0.8 **(B)** 0.5 rad/sec, 0.8

(C) 8 rad/sec, 0.5 **(D)** $\sqrt{8}$ rad/sec, 5

d. Number of assymptotes in root locus for the system having open loop transfer function having 5 poles and 2 zero are

(A) 2 **(B)** 5
(C) 1 **(D)** 3

e. The transfer function of a system is $H(s) = \frac{1000}{(1+0.1s)(1+0.01s)}$ the corner frequencies are

(A) 0.1 and 0.01 rad/s **(B)** - 0.1 and - 0.01 rad/s
(C) 10 and 100 rad/s **(D)** -10 and -100 rad/s

f. For $\xi = 1$, the system is

(A) Over damped **(B)** Under damped
(C) Critical damped **(D)** Unstable

g. The phase shift of $G(s) = \frac{1}{s^2}$ is

(A) 90^0 **(B)** -90^0
(C) 180^0 **(D)** -180^0

h. By increasing the gain K of the system, the steady state error of the system

(A) increases **(B)** decreases
(C) remains unaltered **(D)** none of these

i. The resonant peak is given by

(A) $M_r = \frac{1}{2\xi\sqrt{1-\xi^2}}$ **(B)** $M_r = \frac{1}{\xi\sqrt{1-\xi^2}}$

(C) $M_r = \frac{1}{\xi\sqrt{1+\xi^2}}$ **(D)** $M_r = \frac{1}{2\xi\sqrt{1+\xi^2}}$

j. For the given block diagram C(s) / R(s) is

(A) $\frac{G(s)}{1-G(s)H(s)}$

(B) $\frac{G(s)}{1+G(s)H(s)}$

(C) $\frac{H(s)}{1-G(s)H(s)}$

(D) $\frac{H(S)}{1+G(s)H(s)}$

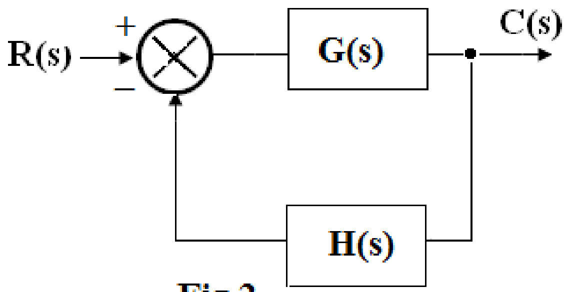

Fig.2

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

Q.2 a. Write the differential equation describing the dynamics of the system shown in Fig.3 and find $\frac{X_2(s)}{F(s)}$ **(8)**

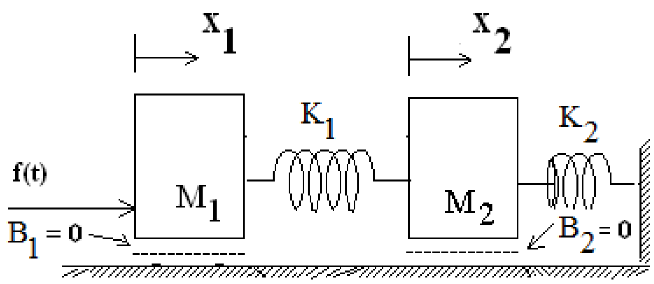

Fig.3

b. Obtain the F-I and F-V analogy of (a). **(8)**

Q.3 a. In the Fig.4, identify the set of state variables and draw the signal flow graph of the circuit.

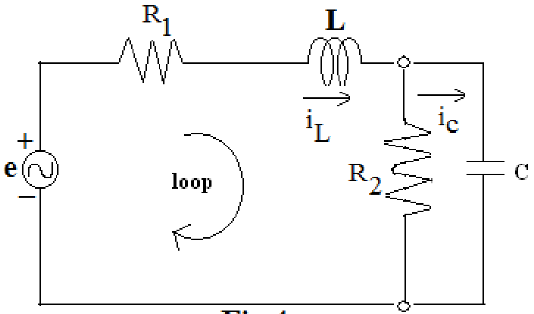

Fig.4

Also, determine transfer function from signal flow graph. **(10)**

b. Find the overall transfer function of the system in Fig.5. **(6)**

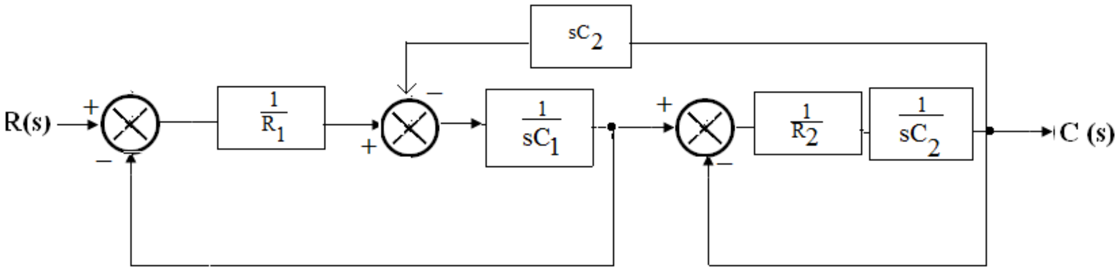

Fig.5

Q.4 a. Explain how the parameter variation is reduced by the use of feedback. **(8)**

b. What are different controller components? Explain in brief. **(8)**

Q.5 a. A second order system with $\xi = 0.5$ and $\omega_n = 6$ rad /sec is subjected to a unit step input. Determine the rise time, peak time, settling time and peak overshoot. **(8)**

b. The transfer function of a unity feedback system is $G(s) = \dfrac{10}{s(s+1)}$.

Find the dynamic error coefficient and steady state error to the input $r(t) = P_0 + P_1 t + P_2 t^2$ **(4)**

c. A unity negative feedback control system has open loop transfer function is $G(s) = \dfrac{K(s+1)(s+2)}{(s+0.1)(s-1)}$ using Routh stability criterion, determine the range of values of K for which the closed loop system has 0,1 or 2 poles in the right – half of S plane. **(4)**

Q.6 a. The open loop transfer function of feedback system is $\dfrac{K}{s(s+4)(s^2+4s+20)}$.

Draw root locus for this system. **(10)**

b. Explain the sensitivity of the roots of the characteristics equation. **(6)**

Q.7 a. Why logarithmic scale is used for Bode plot ? Sketch the Bode plot for the transfer function $H(s) = \dfrac{1000}{(1+0.1s)(1+0.001s)}$ determine (i) Phase margin (ii) Gain margin. **(2+6)**

b. The forward path transfer function of a unity feedback control system is $G(s) = \dfrac{100}{(s+6.54)}$ find the (i) resonance peak (ii) resonance frequency and (iii) bandwidth. **(8)**

Q.8 a. What is the necessity of compensating network? Explain phase lead compensator and give its comparison with phase lag compensator. **(8)**

b. Design a lead compensator for the system shown in Fig. 6. Given that $\omega_n = 4$ rad / sec and $\xi = 0.5$ for compensated system. **(8)**

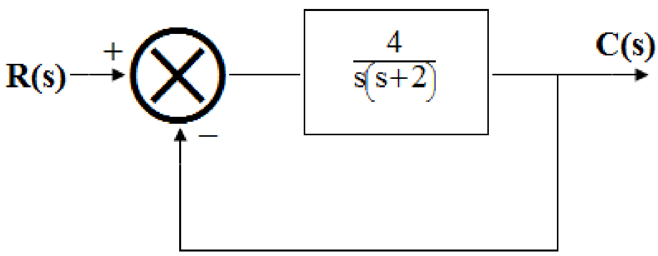

Fig.6

Q.9 a. A system with state model is $\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$

Where u (t) is unit step occurring at t = 0 and $x^T(0) = [1 \quad 0]$. Obtain the time response of the system and compute state transition matrix. **(8)**

b. Test the following system for controllability and observability. **(8)**

$$\dot{x} = \begin{bmatrix} -3 & 1 & 1 \\ -1 & 0 & 1 \\ 0 & 0 & 1 \end{bmatrix} x + \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 2 & 1 \end{bmatrix} u \text{ and } y = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 1 & 0 \end{bmatrix} x.$$