ROLL NO. _____

Code: AE61 **Subject: CONTROL ENGINEERING**

AMIETE – ET

Time: 3 Hours **JUNE 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 transfer function is defined only for

(A) linear time varying systems **(B)** linear time invariant systems
(C) linear & non linear systems **(D)** all of these

b. A polar plot crosses the real axis at (-1+j0) point. The phase margin of the system is

(A) -1^o **(B)** 0^o
(C) -180^o **(D)** $+180^o$

c. The root locus plot of the system having the loop transfer function $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$ has

(A) no breakaway point **(B)** three real breakaway points
(C) only one real breakaway point **(D)** none of these

d. A transfer function which has all its poles and zeros only in the left half of the s-plane is called

(A) an all pass transfer function
(B) a minimum phase transfer function
(C) a non-minimum phase transfer function
(D) none of these

e. For the pole factor $1/(s+5)$, the corner frequency is

(A) 1/5 **(B)** 5
(C) -5 **(D)** -1/5

f. For a standard second-order system described by the characteristic equation as $s^2 + 2\zeta\omega_n s + \omega^2_n = 0$ the term ω_n indicates

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

g. Which of the following compensation scheme increases bandwidth of system

(A) lead compensation **(B)** lag compensation
(C) feedback compensation **(D)** forward compensation

h. If the system has non- repeated poles on jω axis (imaginary axis) , the system is

(A) stable **(B)** unstable
(C) marginally stable **(D)** conditionally stable

i. For overdamped system, the damping ratio is

(A) zero **(B)** one
(C) more than one **(D)** infinity

j. If Laplace transform of f(t) is F(s). The Laplace transform of df(t)/dt is

(A) F(s)/s **(B)** sF(s)-f(0)
(C) sF(s) **(D)** $s^2F(s)$

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

Q.2 a. Define the terms servomechanism? Derive the transfer function of an armature controlled dc servomotor. **(8)**

b. Write the dynamic equation in respect of the mechanical system given in Fig.1 below, also draw F-V analogous circuit. **(8)**

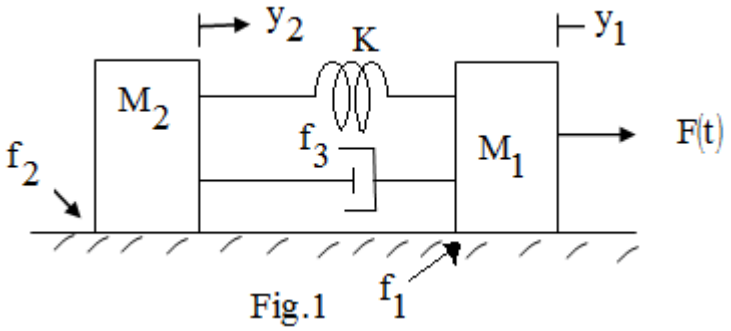

Fig.1

Q.3 a. Determine the transfer function C(s) /R(s) for the block diagram shown in Fig.2 below. **(8)**

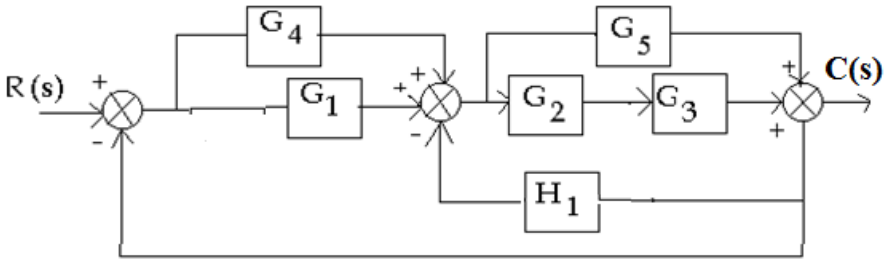

Fig.2

b. Reduce the signal flow graph shown in Fig.3 below using Mason's gain formula: **(8)**

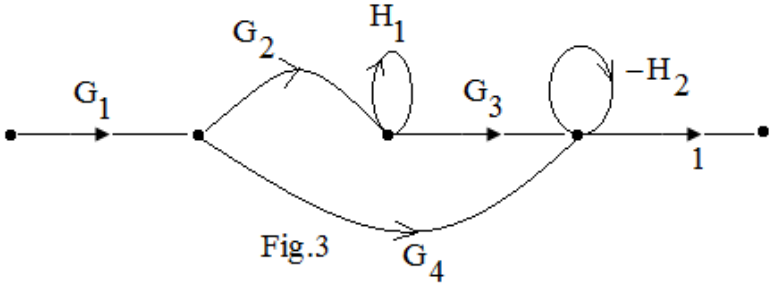

Fig.3

Q.4 a. Discuss the effect of negative feedback on the following:
(i) Disturbance
(ii) Stability
(iii) Parameter variation
(iv) System Dynamics **(8)**

b. Write short technical note on controller components using its block diagram. **(8)**

Q.5 a. A unity feedback system is characterized by the open loop transfer function

$$G(s) = \frac{1}{s(0.5s+1)(0.2s+1)}$$

Determine the steady state error for unit step, unit ramp and unit acceleration input**.** **(8)**

b. Using Routh–Hurwitz stability criterion, determine the stability of the following characteristic polynomial:

$$F(s) = s^6 + 4s^5 + 12s^4 + 16s^3 + 41s^2 + 36s + 72$$ **(8)**

Q.6 Sketch the root loci for the system whose open loop transfer function is given by $G(s)H(s) = \frac{K}{s(s+2)(s^2+6s+25)}$ **(16)**

Q.7 a. Derive the correlation between time and frequency domain responses by considering standard second order control system. **(6)**

b. Given the open loop transfer function. **(10)**

$$G(s)H(s) = \frac{20}{s(s+2)(s+10)}$$

Sketch the Bode plot of the system and determine the following:
(i) gain margin (ii) phase margin

Q.8 a. Explain the tuning of PID controllers. **(8)**

b. Discuss realization of basic compensators. **(8)**

Q.9 a. Discuss controllability and observability. **(4)**

b. The vector matrix differential equation describing the dynamics of the system is given by $\dot{X} = \begin{bmatrix} 0 & 1 \\ -6 & -5 \end{bmatrix} X$.

Obtain the solution of the above equation if $X(0) = [0 \quad 1]^T$ **(12)**