ROLL NO. _____

Code: AE61 **Subject: CONTROL ENGINEERING**

AMIETE – ET

Time: 3 Hours **DECEMBER 2012** **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. A system with gain margin close to unity or a phase margin close to zero is

(A) highly stable **(B)** oscillatory
(C) relatively stable **(D)** unstable

b. 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

c. Closed-loop control systems should have which of the following properties

(A) low sensitivity to changes in the plant
(B) Good resolution against disturbances
(C) Desirable responses to command
(D) All of these

d. Electrical time-constant of an armature-controlled DC servomotor is

(A) equal to mechanical time-constant.
(B) smaller than mechanical time-constant.
(C) larger than mechanical time-constant.
(D) not related to mechanical time-constant.

e. The transfer function T(s) for the given Fig.1 is

(A) $50 / s^2 + 10s +5$
(B) $20/ s^2 + 10s +25$
(C) $20s / s^2 + 10s +5$
(D) $s^2 + 10s +5$

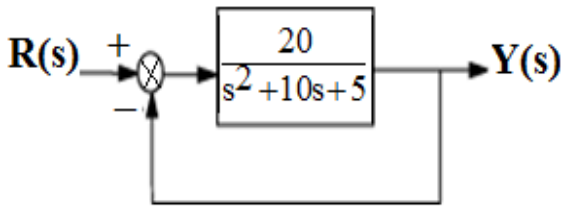

Fig.1

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 $1/\zeta\omega_n$ indicates

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

g. The open loop transfer function has 4 poles and 1 zero. The number of branches of root locus is

(A) 4 **(B)** 1
(C) 5 **(D)** 3

h. Polar plot of $G(j\omega) = \dfrac{1}{[j\omega(1+j\omega\tau)]}$

(A) crosses the negative real axis.
(B) crosses the negative imaginary axis.
(C) crosses the positive imaginary axis.
(D) None of these

i. The eigen values of the state model are the same as the
(A) closed loop poles **(B)** open loop poles
(C) both **(A)** & **(B)** **(D)** none of these

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)** r = 2n

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

Q.2 a. Describe a two phase AC servomotor and derive its transfer function. **(8)**

b. Write the dynamic equation in respect of the mechanical system given in Fig.2 below **(8)**

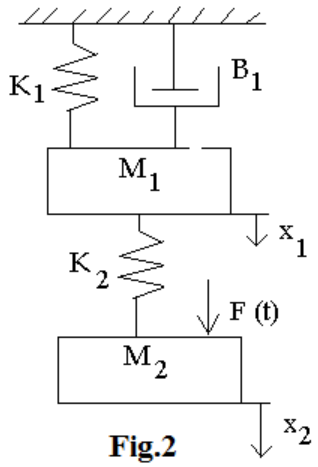

Fig.2

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

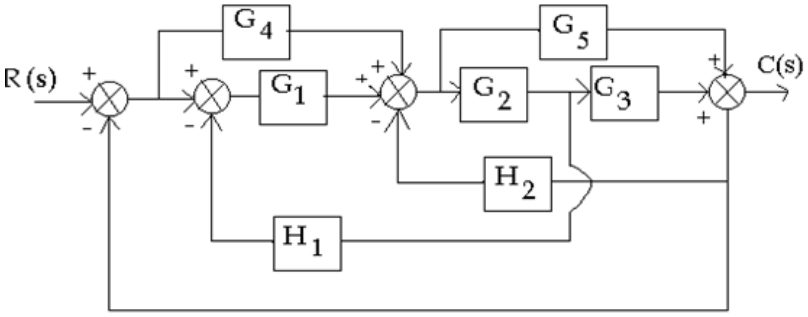

Fig.3

Q.4 a. What are the main features of stepper motor which are responsible for its wide spread use? **(4)**

b. A servo system is represented by the signal flow graph shown in Fig.4 below. The nominal values of parameters are K_1=1, K_2= 5 and K_3=5. Determine the overall transfer function $Y(s)/R(s)$ and its sensitivity to changes in K_1 under steady dc conditions, i.e., s = 0. **(12)**

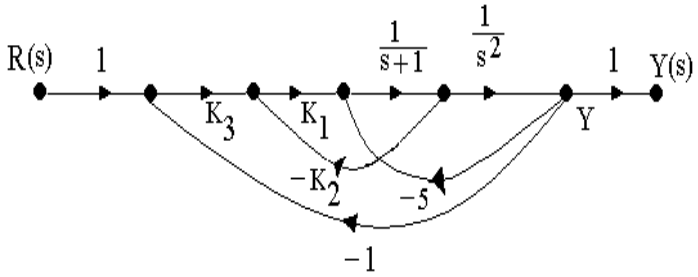

Fig.4

Q.5 a. For the system shown in the block diagram (Fig.5) below determine the values of gain K_1 and velocity feedback constant K_2, so that the maximum overshoot with a unit step input is 0.25 and the time to reach the first peak is 0.8 sec. Thus obtain the rise time and settling time for 5% tolerance band. **(10)**

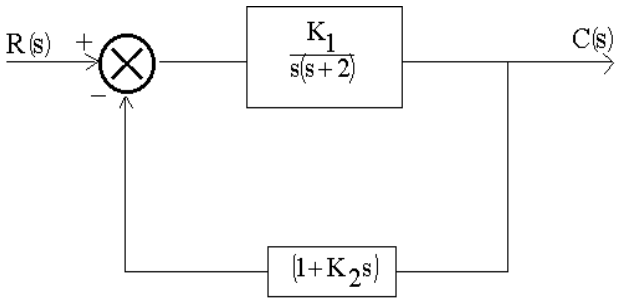

Fig.5

b. Obtain the unit-impulse response of a unity feedback control system whose open loop transfer function is $G(s)=\frac{2s+1}{s^2}$. **(6)**

Q.6 Sketch the root loci for the system shown in Fig.6 below **(16)**

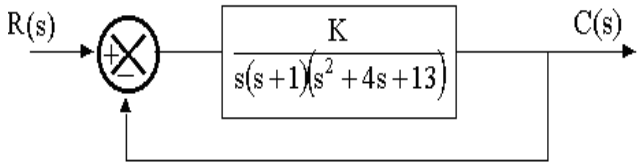

Fig.6

Q.7 a. State and explain the Nyquist stability criterion. **(6)**

b. The open loop transfer function of a unit feedback control system is **(10)**

$$G(s)H(s)=\frac{10s}{s(1+0.5s)(1+0.1s)}$$

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

Q.8 a. Consider the control system shown in Fig.7 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 percent for constant inputs. Find K_C that satisfies this specification. **(8)**

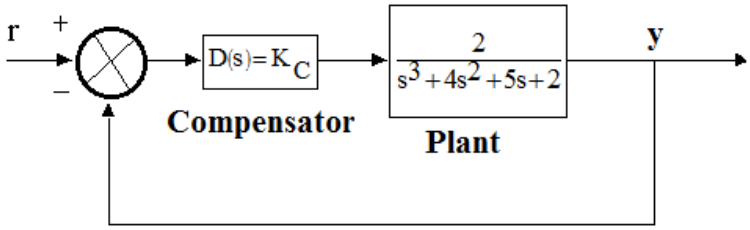

Fig.7

b. Discuss phase lead compensator. **(8)**

Q.9 a. What do you understand by state transition matrix? Write the properties of it. **(8)**

b. By using Cayley-Hamilton technique find $f(A)=A^{10}$ for $A=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}$. **(8)**