ROLL NO. _____

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

AMIETE – ET (Current & New Scheme)

JUNE 2018

Time: 3 Hours **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 of the given block diagram is

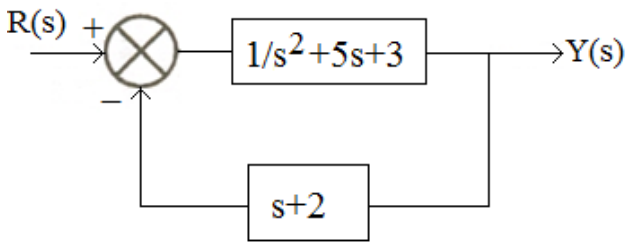

Fig.1

(A) s^2+5s+3 **(B)** $s+2/s^2+5s+3$
(C) $1/s^2+6s+5$ **(D)** $s^3+7s^2+13s+6/\ s+2$

b. The transfer function is dependent on the
(A) parameters of the system **(B)** initial conditions of the system
(C) input of the system **(D)** output of the system

c. Stability of open loop is
(A) greater than closed loop **(B)** lesser than closed loop
(C) equals to closed loop **(D)** none of these

d. If all the roots of the characteristic equation have negative real parts, then the system is
(A) marginal stable **(B)** stable
(C) unstable **(D)** conditionally stable

e. 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

f. 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

g. The effect of LEAD compensation on the system is
(A) It increases the stabilty and makes the speed response slower
(B) It decreases the stabilty and makes the speed response faster
(C) It decreases the stabilty and makes the speed response slower
(D) It increases the stabilty and makes the speed response faster

h. An open loop system represented by the transfer function
G(s) = (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

i. Polar plot of $G(j\omega) = \frac{1}{j\omega(1+j\omega\tau)}$
(A) crosses the negative real axis
(B) crosses the negative imaginary axis
(C) crosses the positive imaginary axis
(D) None of these

j. 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

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

Q.2 a. Explain servomechanism with suitable examples and diagram. **(8)**

b. For the electrical network shown in Fig.2, find the transfer function V_o/V_i **(8)**

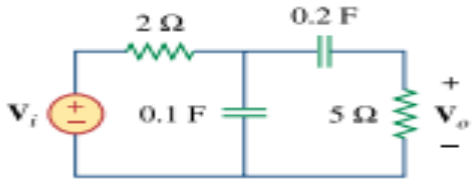

Fig.2

Q.3 a. Find the overall transfer function by using Mason's gain formula for the signal flow graph, shown in Fig.3.. **(8)**

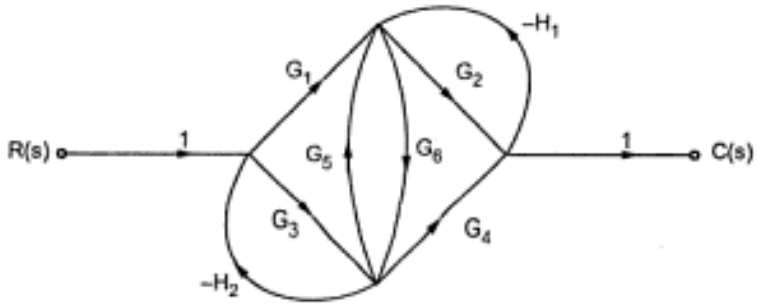

Fig.3

b. Reduce the block diagram to its simplest form and obtain C(s)/ R(s). **(8)**

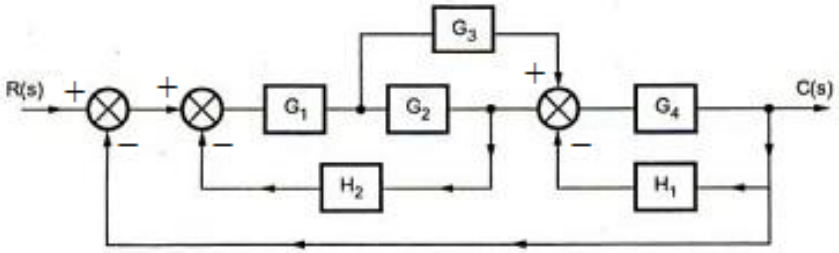

Fig.4

Q.4 a. Explain working of stepper motor with neat diagram. Give its field of applications. **(6)**

b. For the block diagram shown in Fig.5, determine the sensitivity S_{α}^{T} of Transfer function T(s) = C(s)/R(s) to variation in parameter α at ω=0.1 and 5 rad/sec. **(10)**

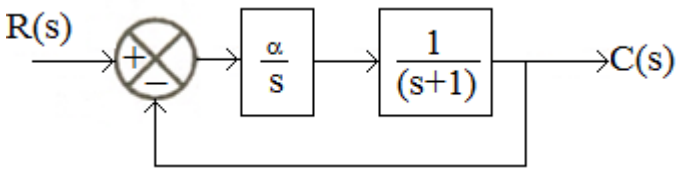

Fig.5

Q.5 a. Obtain the unit-impulse response of a unity feedback control system whose open loop transfer function is $G(s) = \frac{2s+1}{s^2}$ **(8)**

b. The characteristic equation of a closed loop control system is given as $s^4 + 10s^3 + 35s^2 + 50s + 24 = 0$ .Find the number of roots which lie in the right of vertical axis located at s = -2. **(8)**

Q.6 Draw the approximate root locus diagram for a closed loop system whose loop transfer function is given by $G(s)H(s)=\frac{K}{s(s+5)(s+10)}$ comment on the stability. **(16)**

Q.7 Consider the system shown in Fig. 6. Draw the Bode-plot of the open loop transfer function G(s) with K=1. Determine the phase margin and gain margin. Find the value of K to reduce the phase margin by 10^o **(16)**

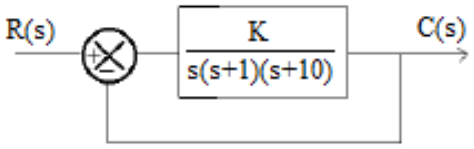

Fig.6

Q.8 a. Compare the response of a P+D controller with that of a purely proportional controller with unit step input, the system being a type–1. **(8)**

b. State the effects and limitations of phase lag compensators. **(8)**

Q.9 a. A linear time invariant system is characterized by the homogeneous state equation

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -6 & 5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

The initial state is $\begin{bmatrix}x_1\\ x_2\end{bmatrix}=\begin{bmatrix}1\\ 0\end{bmatrix}$

Find the resolving matrix $\phi(s)$, state transition matrix $\phi(t)$ and $\phi^{-1}(t)$ and the solution of the given equation. **(10)**

b. Define the transfer function of a linear time-invariant system in terms of its differential equation model. What is the characteristic equation of the system? **(6)**