ROLL NO. _____

Code: AE61 **Subject: CONTROL ENGINEERING**

AMIETE – ET

Time: 3 Hours **DECEMBER 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 selection of a particular mathematical model for a given system is governed by

(A) The accuracy desired
(B) Coordinate system
(C) Type of system variables and inter-relation amongst the system variables
(D) Both **(B)** and **(C)**

b. The transfer function approach is more suited for

(A) SISO system **(B)** MIMO system
(C) Optimal control problem **(D)** Both **(B)** and **(C)**

c. Block diagram of a system is

(A) an algebraic representation of the system
(B) a pictorial representation of the system
(C) a graphical representation of the system
(D) a controlled representation of the system

d. In reference to signal flow graphs and output node has

(A) one incoming branch and one outgoing branch
(B) at least one incoming branch and more than one outgoing branches
(C) one outgoing branch only
(D) incoming branches but no outgoing branch

e. The overall transfer function of a positive feedback system in terms of forward path transfer function, G(s) and the feedback path transfer function, H(s) is given by

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

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

f. Addition of a feedback path to an open loop control system results in

(A) faster transient response **(B)** lesser gain
(C) stability may be affected badly **(D)** all of these

g. For a stepper motor with its status wound for 4 – phase, a stepping angle of 4.5° is desired, what should be the number of teeth on rotor?

(A) 10 **(B)** 20
(C) 60 **(D)** 50

h. Three basic elements of a hydraulic system are

(A) Resistance, capacitance and inductance
(B) Volume, density and flow rate
(C) Viscosity, density and flow rate
(D) Resistance, viscosity and flow rate

i. The Routh- Hurwitz criterion gives

(A) absolute stability **(B)** relative stability
(C) comparative stability **(D)** specific stability

j. Each branch of the root-loci of the characteristic equation of a closed-loop control system begin from

(A) open loop zero **(B)** open loop pole
(C) can start from anywhere **(D)** none of these

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

Q.2 a. Give a simple analysis of an electric water heater system. **(8)**

b. Find the equation describing the motion of the mechanical system shown in Fig.1 below K stands for compliance of the spring. **(8)**

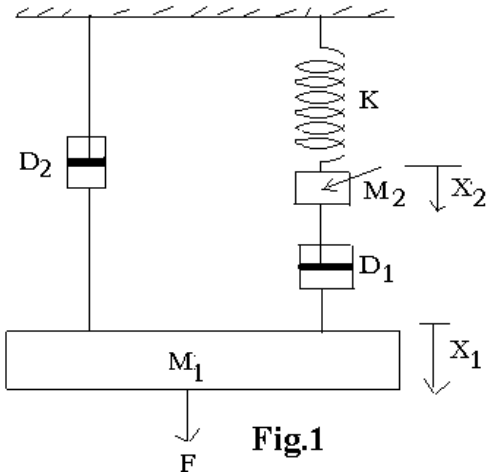

Fig.1

Q.3 a. Give a systematic procedure for reduction of complicated block diagrams. Illustrate the procedure with the help of an example. **(8)**

b. Determine the overall transfer function C(s) / R(s) of the system represented by the signal flow graph given below. **(8)**

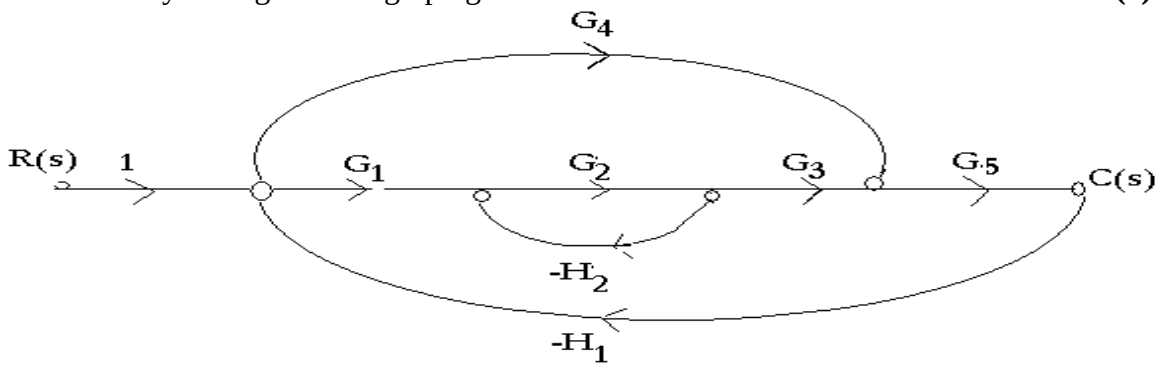

Fig.2

Q.4 a. Write a note on stepper motors. **(8)**

b. Given a closed loop control system with the forward path transfer function = 32 and the feedback path transfer function = 0.01. Calculate the closed loop transfer function if the system is
(i) Negative feedback
(ii) Positive feedback **(8)**

Q.5 a. In reference to control system engineering define the term performance index. What are various qualities which a suitable performance index should possess? **(8)**

b. What possible difficulties may be faced while implementing the Routh – Hurwitz criterion for determination of stability of linear control systems? Explain through examples how these difficulties can be faced? **(8)**

Q.6 Give a stepwise procedure to draw the root locus of a given control system. Illustrate the procedure with the help of an example. **(16)**

Q.7 a. Define the terms gain crossover, phase crossover, gain margin and phase margin. Show these quantities on a typical Nyquist plot. **(8)**

b. Explain how the initial slope of the log-magnitude versus frequency plot of a transfer function is related to the type of the system represented by the given transfer function. **(8)**

Q.8 a. Explain the reaction curve method for the experimental determination of controller setting of a given control system as given by loop. **(8)**

b. The open – loop transfer function of a unity feedback control system is given by $G(s) = \frac{10}{s(s+4)}$

Design a suitable compensator so that the static velocity error constant of the compensated system be 50 sec^{-1} without appreciably changing the original closed – loop poles located at $-2 \pm j\sqrt{5}$ **(8)**

Q.9 a. Determine stability of the system described by equation: **(8)**

$$\dot{X} = \mathbf{A}X$$

$$A = \begin{bmatrix} -1 & -2 \\ 1 & -4 \end{bmatrix}$$

by using liapunov's direct method.

b. Develop a state space model for a system whose dynamics is represented by the following equation.

$$\frac{d^3y(t)}{dt^3} + 3\frac{d^2y(t)}{dt^2} + 5\frac{dy(t)}{dt} + 7y = 11u(t)$$ **(8)**