ROLL NO. ___________________

Code: AE61/AE109 Subject: CONTROL ENGINEERING

AMIETE – ET (Current & New Scheme)

JUNE 2015

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 steady state output of a unit feedback control system is

(A) Equal to reference input **(B)** More than reference input
(C) Not related to reference input **(D)** Very near to reference input

b. The type of a transfer function denotes

(A) The number of zeros at origin **(B)** The number of poles at origin
(C) The number of poles at infinity **(D)** The number of infinity poles

c. With a negative feedback, the system gain and stability

(A) Decreases, Increases
(B) Increases, Decreases
(C) Increases, Increases
(D) Decreases, Decreases

d. The transfer function of a system in regenerative feedback is given by:

(A) $\frac{C(s)}{R(s)}=\frac{G(s)}{1+G(s)H(s)}$ **(B)** $\frac{C(s)}{R(s)}=\frac{G(s)H(s)}{1+G(s)H(s)}$

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

e. It is given that $G(s)=K/[s^3(1+sT)]$ and the system is operated in a closed loop with unit feedback. The order and type of the closed-loop system are

(A) 2 and 3 **(B)** 3 and 4
(C) 3 and 0 **(D)** 4 and 0

f. Regenerative feedback means the output is feedback with

(A) Positive sign **(B)** Negative sign
(C) Step input **(D)** Oscillation

g. Feedback control system is basically

(A) High pass filter **(B)** Band pass filter
(C) Low pass filter **(D)** Band stop filter

h. Signal flow graph is a

(A) Topological representation of a set of differential equation
(B) Bode plot
(C) Polar plot
(D) None of these

i. The transient response of a system with feedback compared to that of without feedback

(A) Decays more quickly **(B)** Decays slowly
(C) Rises at a slower rate **(D)** Rises at a faster rate

j. The ratio of settling time to time constant for a tolerance of 2% of a under damped system is approximately

(A) 6 **(B)** 8
(C) 1 **(D)** 12

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

Q.2 a. Give the comparison between the open loop and closed loop systems. **(4)**

b. With neat block diagram explain an automatic control system. **(4)**

c. Consider the circuit (electrical) of Figure 1 **(8)**

(i) Identify a set of state variables (physical variables).

(ii) Draw the signal flow graph of the circuit in terms of the state variables identified in part (i).

(iii) From the signal flow graph, write the state variable equations of the circuit.

(iv) From the signal flow graph, determine the transfer function $E_C(s)/E(s)$.

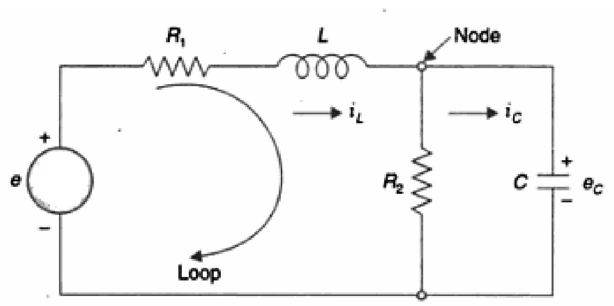

Fig.1

Q.3 a. Reduce the system shown in Figure 2 to a single transfer function **(8)**

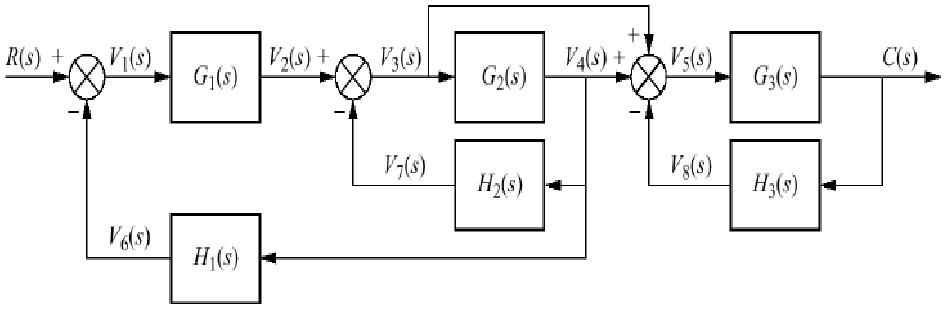

Fig.2

b. For the system shown in Figure 3, determine the gain between y1 and y5 **(8)**

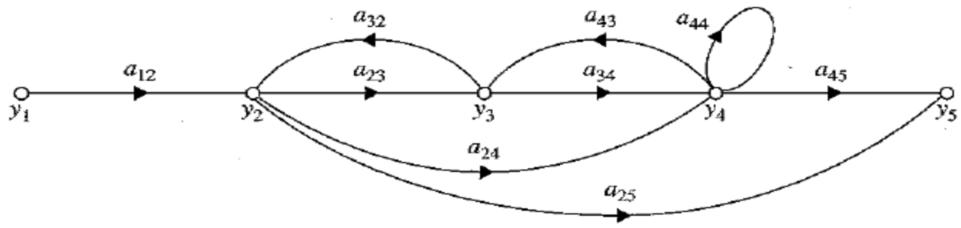

Fig.3

Q.4 a. Consider the feedback control system shown in Figure 4. The normal value of process parameter *K is* 1. Let us evaluate the sensitivity of transfer function T(s)=*C(s)/R(s)* to variations in parameter *K* **(8)**

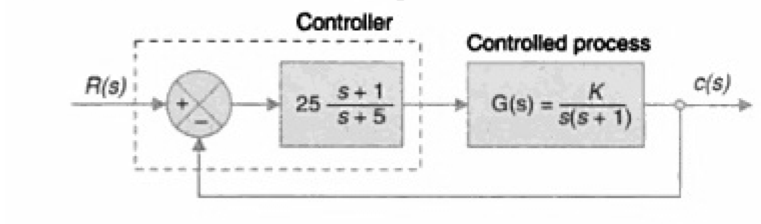

Fig.4

b. For the block diagram of Figure 5, determine the sensitivity S_{α}^{T}, T(s)= C(s)/R(s). Evaluate it at ω = 0.1 and 2 rad (for α = 2). **(8)**

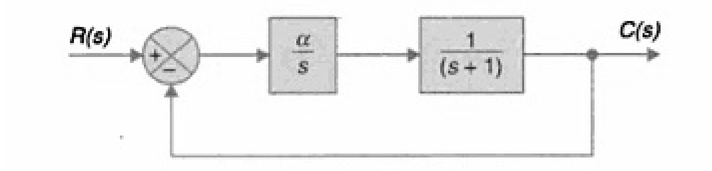

Fig.5

Q.5 a. A unity feedback control system is characterized by an open-loop transfer function. $G(s)H(s) = \frac{K}{s(s+10)}$

Determine the system gain K, so that the system will have a damping ratio of 0.5. For this value of K, find the rise time, peak time, settling time and peak overshoot. Assume that the system is subjected to a step of 1V. **(8)**

b. A unity negative feedback control system has an open-loop transfer function consisting of two poles Two zeros and variable gain K. The zeros are located at –2 and –1: and the poles at –0.1 and +1. Using Routh stablity criterion, determine the range of values of K for which the closed-loop system has 0, 1 and 2 poles in the right-half of s-plane. **(8)**

Q.6 a. Briefly discuss rules followed to plot the root locus. **(8)**

b. A unity feedback control system has an open-loop transfer function of

$$G(s) = \frac{K(s+4/3)}{s^2(s+12)}$$

Plot the root locus. Find the value of K for which all the roots are equal. What is the value of these? **(8)**

Q.7 a. Draw polar plot for the system with the transfer function **(10)**

$$G(s) = \frac{10}{s\,(s+1)(s+2)}$$

b. Explain in detail Nyquist stability criteria. **(6)**

Q.8 a. A unity negative feedback system has an open-loop transfer function of

$$G(s) = \frac{K}{(s+4)}$$

Consider a cascade compensator

$$G_c(s) = \frac{s+\alpha}{s}$$

- Select the values of K and α to achieve

(i) Peak overshoot of about 20%

(ii) Setting time (2%basis) ≈1 sec

- For the values of K and α found in part (a) calculate the unit ramp input steady-state error **(10)**

b. Give the comparisons between phase lag and phase lead compensator. **(6)**

Q.9 a. The simplified block diagram of the controller and the wheelchair is depicted in figure 6. Write down the canonical state variable form for the complete system, Also draw its block diagram (in state variable form). **(8)**

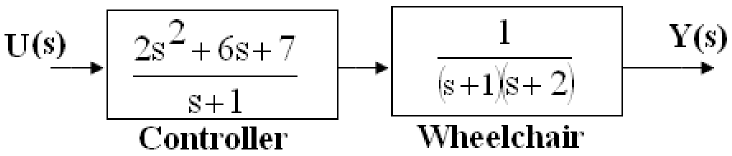

Fig.6

b. Obtain the time response of the following system:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u$$

Where u(t) is a unit step occurring at t=0 and $x^T(0)=[1 \;\; 0]$ **(8)**