ROLL NO. _____

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

AMIETE – ET (Current & New Scheme)

December 2016

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.**
- **Graph and semilog paper to be provided**

Q.1 Choose the correct or the best alternative in the following: **(2×10)**

a. The transfer function approach is more suited for:

(A) SISO system **(B)** MIMO system

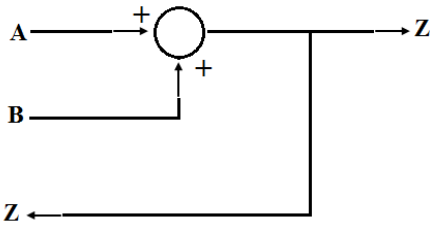
(C) optimal control problem **(D)** Both **(B)** & **(C)**

b. 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)** $\frac{G(s)}{1+G(s)H(s)}$

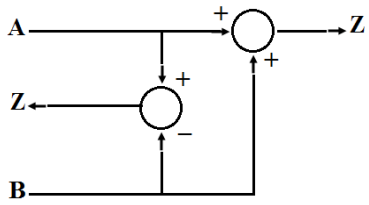
(C) $\frac{1}{1-G(s)H(s)}$ **(D)** $\frac{1}{1+G(s)H(s)}$

c. Consider the system represented by the following block diagram:

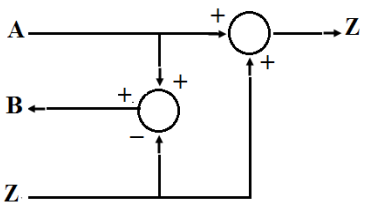


It is equivalent to:

(A)

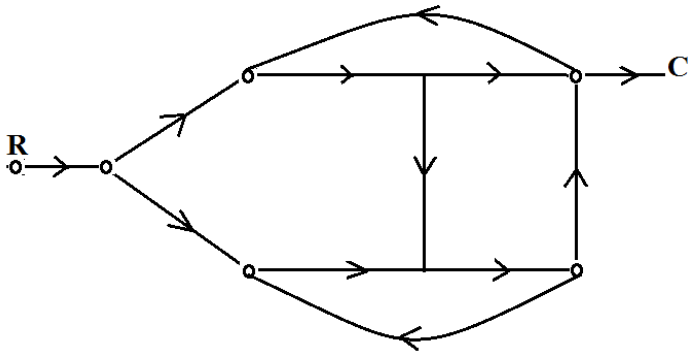


(B)



(C) both **(A)** & **(B)** **(D)** none of these

d. Consider a system represented by the following signal flow graph



It has

(A) three forward paths and two non-touching loops
(B) three forward paths and three loops
(C) two forward paths and two non touching loops
(D) two forward paths and three loops

e. By using feedback in control systems, the sensitivity to parameter variations is improved. This is achieved at the cost of

(A) stability **(B)** transient response
(C) loss of system gain **(D)** reliability

f. A stepper motor has 6 phases winding on its stator and has 12 teeth on rotor. Find the stepping angle

(A) 5° **(B)** 10°
(C) 2.5° **(D)** 60°

g. The steady-state error due to a unit-step input to a type 3 system is

(A) $1/kp$ **(B)** $\frac{1}{1+kp}$
(C) ∞ **(D)** 0

h. The open-loop transfer function of a closed-loop system is given as follows:

$$G(s)H(s)=\frac{k(s+3)}{s(s+1)^2(s+2)}$$

Determine the number of branches of its root loci

(A) 1 **(B)** 2
(C) 3 **(D)** 4

i. The gain for constructing the Bode plot in relation to the following transfer function is

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

(A) 20 **(B)** 5
(C) 10 **(D)** 10/3

j. What happens to the value of static error constants of a system provided with cascade-lag-lead compensator?

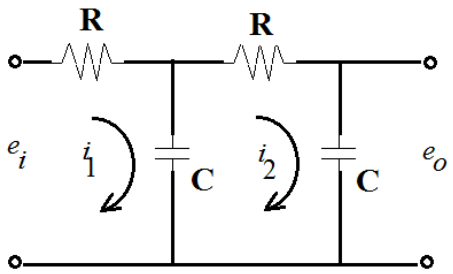
(A) no change **(B)** decreases

(C) increases a little **(D)** increases as desired

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

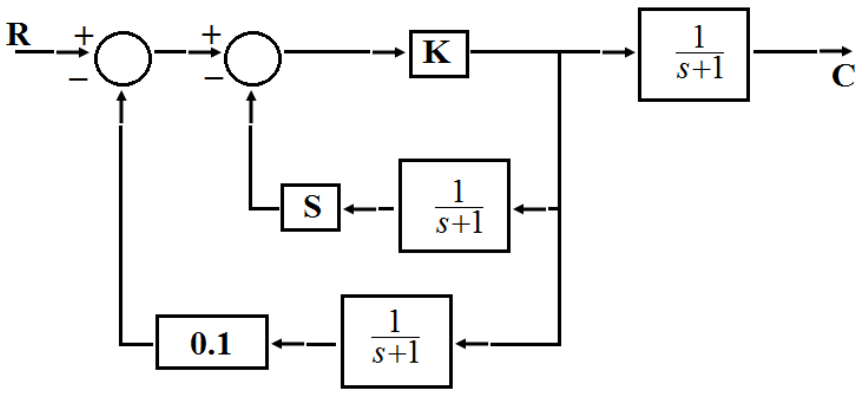
Q.2 a. State the conditions to be satisfied for the principle of superposition to be applicable for a control system. Can a system whose dynamics is represented by the following equation be considered a linear system? If no, explain why? If yes, explain how? $y(t) = mx(t) + b$ **(8)**

b. Derive an expression for transfer function of the circuit shown below:- **(8)**



Q.3 a. State and explain Mason's gain formula in reference to signal flow graphs. What is its utility? **(8)**

b. Reduce the following block diagram, isolating block K in the forward loop. **(8)**



Q.4 a. Explain in detail how does feedback affects the transient response of a control system. **(8)**

b. With the help of a neat diagram explain the power steering mechanism. **(8)**

Q.5 a. Explain the need of testing a control system response to typical test signals. What are the different test signals normally used? Explain their important features. **(8)**

b. A unity feedback control system is given to have the open loop transfer function as

$$G(s) = \frac{k(s+s_1)}{s^2(s+s_2)(s+s_3)}$$

Determine

(i) All error constants

(ii) Steady-state error due to an input represented by

$$r(t) = (R_1 + R_2 t + R_3 t^2)u(t)$$ **(8)**

Q.6 Consider the unity feedback control system with an open-loop transfer function of $G(s) = \frac{k(s+1)(s+2)}{(s+0.1)(s-1)}$

Draw the root loci of the system with gain k as a variable. Determine the value of k for which a closed loop system is critically damped. **(16)**

Q.7 a. Give a step wise procedure to draw Bode plots for the transfer function containing all types of factors. **(8)**

b. Express the following transfer function in the Bode form and determine Bode gain $G(s)H(s) = \frac{10(s+1)}{s(s+3)(s+5)}$ **(8)**

Q.8 a. Explain the reaction curve method for experimental determination of controller settings of a given control system as given by Zeigler and Nichols. **(8)**

b. Give and illustrate with the help of a typical example the design procedure of a cascade lag compensator through Bode plot method. **(8)**

Q.9 Write notes on any **TWO** of the following:-

(i) Controllability and observability.

(ii) Pole placement by state feedback.

(iii) Liapunor's stability criterion. **(2x8 = 16)**