ROLL NO. _______________

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

AMIETE – ET (Current & New Scheme)

Time: 3 Hours **JUNE 2017** **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.

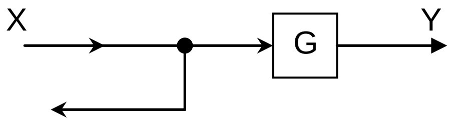
- **Question 1 is compulsory and carries 20 marks. Answer to Q.1 must be written in the space provided for it in the answer book supplied and nowhere else.**
- **The answer sheet for the Q.1 will be collected by the invigilator after 45 minutes of the commencement of the examination.**
- **Out of the 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)**

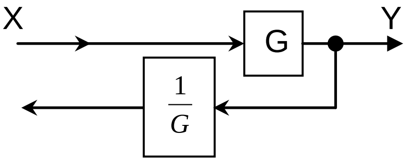
a. Which one is correct for Force – Voltage Analogy?

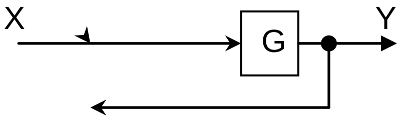
(A) Force – Resistance **(B)** Mass – Voltage
(C) Displacement – Charge **(D)** Spring stiffness - Inductance

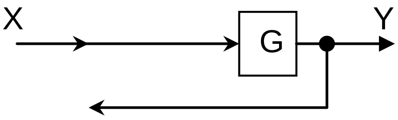
b. The block diagram is shown below

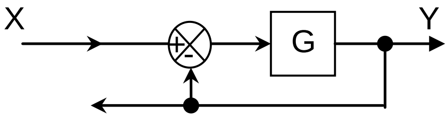


Its equivalent block diagram is

(A)


(B)


(C)


(D)


c. The closed loop system has a bandwidth ___________ times the bandwidth of the open loop system.

(A) K-1 **(B)** 1+K
(C) K+10 **(D)** 100+K

d. While the teeth on all the rotors are perfectly aligned, stator teeth of various stacks differ by an angular displacement of stepper motor, is

(A) $\alpha = \frac{360^\circ}{nT}$ **(B)** $\alpha = \frac{nT}{360^\circ}$

(C) $\alpha = \frac{n \times 360^\circ}{T}$ **(D)** $\alpha = \frac{T}{n \times 360^\circ}$

e. Time response of unity feedback system with $G(s)=\frac{1}{sT}$, when input is unit ramp signal

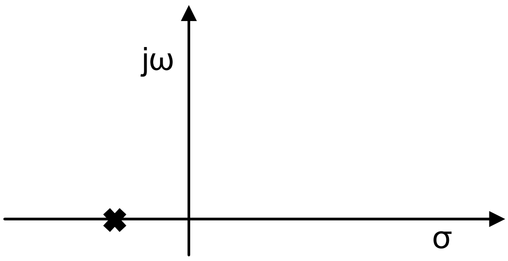
(**A**) $c(t)=1-e^{-t/T}$ (**B**) $c(t)=t-T\left(1-e^{-t/T}\right)$

(**C**) $c(t)=t\left(1-e^{-t/T}\right)$ (**D**) $c(t)=T\left(1-e^{-t/T}\right)$

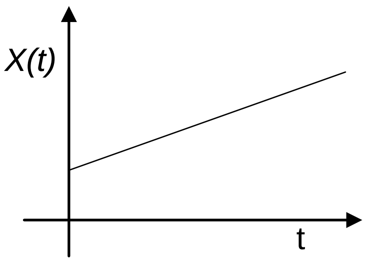
f. The open loop transfer function is $G(s)=\frac{(s+1)}{s^2(s+2)(s+1)^2}$. Type and order of the system is

(**A**) Type 2, Order 5 (**B**) Type 4, Order 2
(**C**) Type 5, Order 2 (**D**) Type 2, Order 4

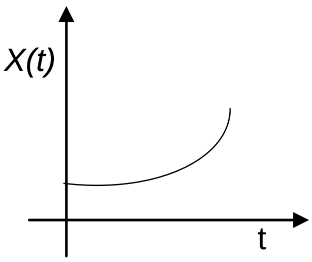
g. The roots in s-plane is given below, the corresponding impulse response is



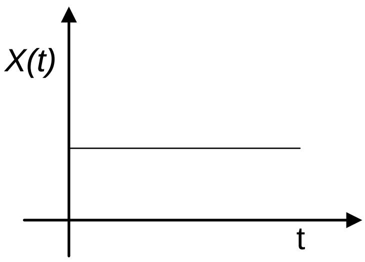
(A)



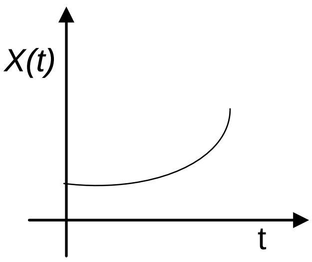
(B)



(C)



(D)



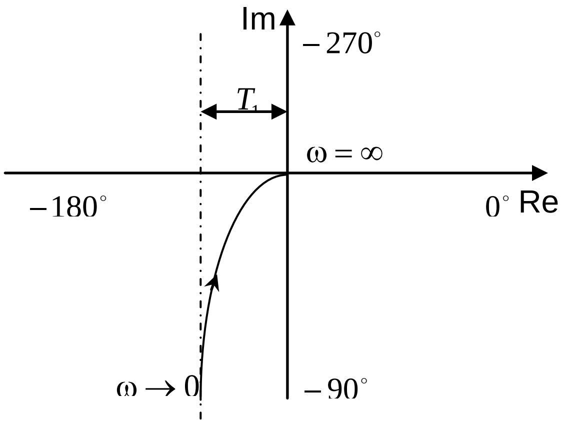
h. A lead compensator _____________ the transient response and ___________ the margin of stability of a system.

(**A**) speeds up, decreases (**B**) speeds down, decreases
(**C**) speeds up, increases (**D**) speeds down, increases

i. Consider the system $\dot{x}=\begin{bmatrix}0 & 1\\ 0 & -4\end{bmatrix}x+\begin{bmatrix}0\\ 2\end{bmatrix}u$, $y=\begin{bmatrix}0 & 2\end{bmatrix}x$. The system is:

(**A**) Controllable, observable (**B**) Controllable, not observable
(**C**) Not controllable, observable (**D**) Not controllable, not observable

j. The polar plot shown below. Equivalent transfer function is



(**A**) $\frac{1}{1+j\omega T_1}$ (**B**) $\frac{1}{(1+j\omega T_1)j\omega}$

(**C**) $\frac{1}{(1+j\omega T_1)(1+j\omega T_2)}$ (**D**) $\frac{1}{(j\omega)^2(1+j\omega T_1)}$

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

Q.2 a. Draw the schematic diagram of a manually controlled closed loop system and explain in detail. **(8)**

b. Write the equations of motion for the double-pendulum system shown in Fig.1. Assume the displacement angles of the pendulums are small enough to ensure that the spring is always horizontal. The pendulum rods are assumed massless with length L, and the springs are attached ¾ of the way down. **(8)**

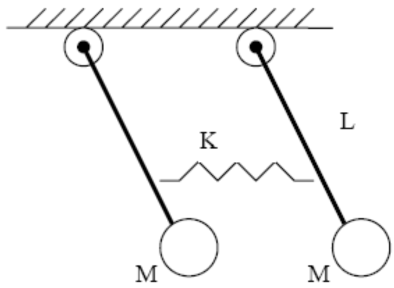


Fig.1. Double Pendulum

Q.3 a. Determine the overall transfer function for the system shown in fig.2. **(8)**

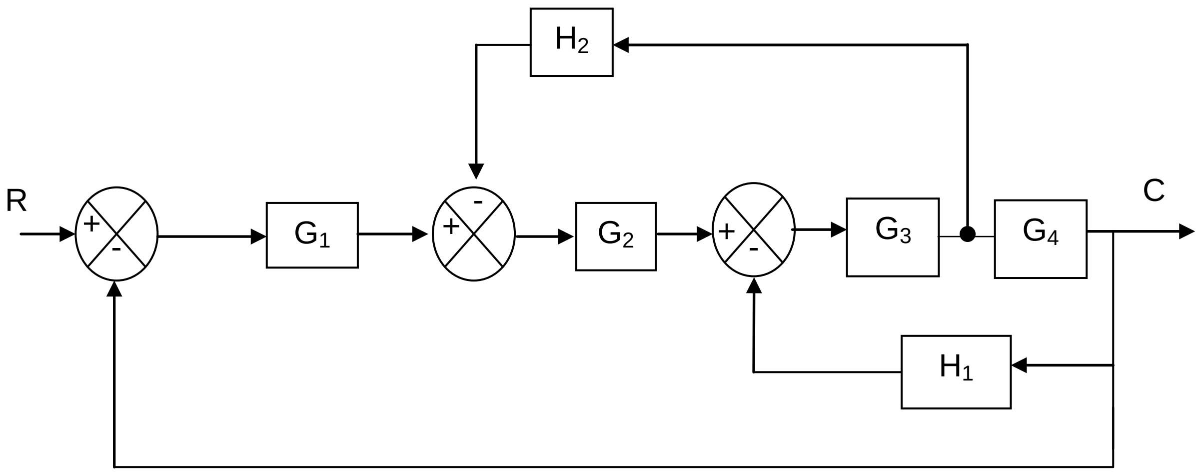


Fig. 2

b. Find the transfer function for the system shown in fig. 3 using Mason's gain formula. **(8)**

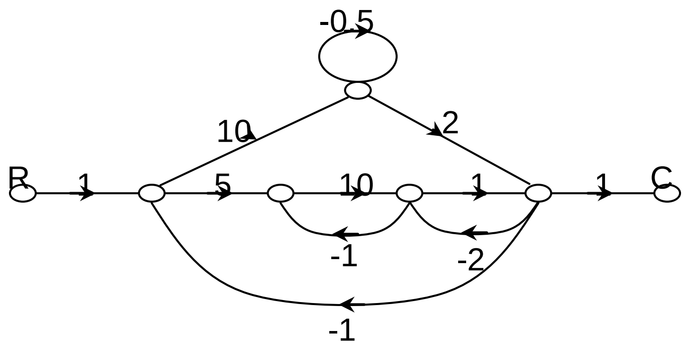


Fig. 3

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

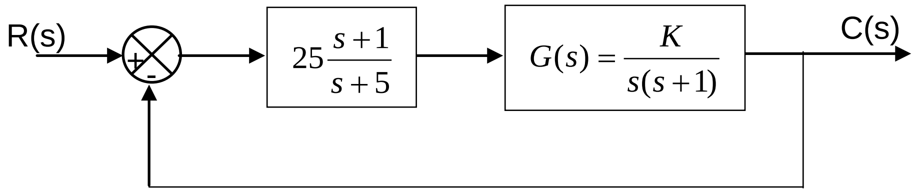


Fig. 4. Feedback control system

b. With neat diagram explain the working principle of Hydraulic valve. **(8)**

Q.5 Consider the following state-space representation:

$$\begin{bmatrix}\dot{x}_1(t)\\ \dot{x}_2(t)\end{bmatrix}=\begin{bmatrix}-3 & 1\\ 0 & -2\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\end{bmatrix}+\begin{bmatrix}1\\ 2\end{bmatrix}u(t), \quad y(t)=\begin{bmatrix}1 & 1\end{bmatrix}\begin{bmatrix}x_1(t)\\ x_2(t)\end{bmatrix}$$

Obtain the system transfer function by using two different methods. Determine the stability of the system. **(16)**

Q.6 A unity feedback control system has an open loop transfer function of $G(s)=\frac{K(s+1)(s+2)}{(s+0.1)(s-1)}$. Plot the root locus of the system with gain K as a variable. As an aid to plotting determine: asymptotes, centroid, breakaway point, the gain at which the root locus crosses jω axis. Find from the root locus plot the value of gain K for which a closed loop system is critically damped. **(16)**

Q.7 Sketch the bode plot for the following transfer function and determine phase margin and gain margin. $G(s)=\frac{75(1+0.2s)}{s(s^2+16s+100)}$. **(16)**

Q.8 Explain in detail about realization of basic compensators. **(16)**

Q.9 a. Consider a control system with state model $\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix}=\begin{bmatrix}0 & 1\\ -2 & -3\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}+\begin{bmatrix}0\\ 2\end{bmatrix}u;\ \begin{bmatrix}x_1(0)\\ x_2(0)\end{bmatrix}=\begin{bmatrix}0\\ 1\end{bmatrix}$, u is the unit step signal. Compute the state transition matrix and also find the state response, t>0. **(8)**

b. Determine the stability of the system described by the following equation using direct method of Liapunov: $\dot{x}=Ax,\ A=\begin{bmatrix}-1 & -2\\ 1 & -4\end{bmatrix}$. **(8)**