ROLL NO. _____

**Code: AE61** **Subject: CONTROL ENGINEERING**

# AMIETE – ET

## DECEMBER 2012

**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:** **$(2\times10)$**

a. The principle of homogeneity and super position is applied to

**(A)** Linear time variant system **(B)** Non linear time variant system
**(C)** Linear time invariant system **(D)** Non linear time invariant system

b. The Laplace transform of a function f(t) is given by

**(A)** $\int_0^{\infty} f(t)e^{st}dt$ **(B)** $\int_0^{\infty} f(t)e^{-st}dt$

**(C)** $\int_{-\infty}^{0} f(t)e^{+st}dt$ **(D)** $\int_{-\infty}^{0} f(t)e^{-st}dt$

c. The transfer function of system is $T(s) = K/[s^3(1+sT)]$. The type and order of the system will be

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

d. A position control is_____

**(A)** an automatic regulating system **(B)** a servo mechanism
**(C)** a process control system **(D)** stochastic control system

e. If a torque $T_1$ is transferred from a gear with $N_1$ teeth to gear with $N_1$ teeth to gear with $N_2$ teeth, the value of the torque received at the shaft of second gear is

**(A)** $\left(\frac{N_1}{N_2}\right)T_1$ **(B)** $\left(\frac{N_2}{N_1}\right)T_1$

**(C)** $N_1T_1$ **(D)** $\left(\frac{N_2}{N_1}\right)^2 T_1$

f. The value of $\frac{X_3}{X_1}$ as shown in Fig. 1

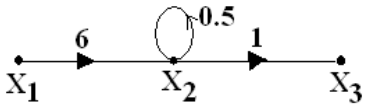


**Fig. 1**

**(A)** 8 **(B)** 2
**(C)** 12 **(D)** 5

g. The transient response of a system with feedback when compared to the same system without feedback will

**(A)** delay more quickly **(B)** delay slowly
**(C)** rises at the slower rate **(D)** rises at the faster rate

h. If some pole of a system lies on the imaginary axis, the system is

**(A)** absolutely stable **(B)** conditionally stable
**(C)** marginally stable **(D)** unstable

i. The starting point of a root locus is

**(A)** open-loop pole **(B)** closed loop pole
**(C)** open-loop zero **(D)** closed loop zero

j. A decade frequency range is specified by

**(A)** $\frac{\omega_2}{\omega_1} = 2$ **(B)** $\frac{\omega_2}{\omega_1} = 10$

**(C)** $\frac{\omega_2}{\omega_1} = 3$ **(D)** $\frac{\omega_2}{\omega_1} = 6$

---

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

---

**Q.2** a. Calculate the transfer function of the electrical network as shown in Fig.2. **(6)**

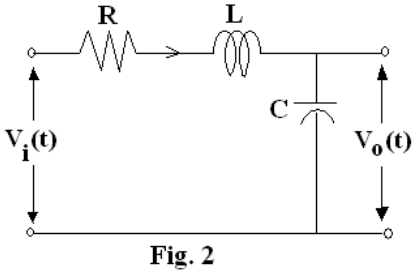


**Fig. 2**

b. Explain the significance of servomechanisms in control system applications. **(4)**

c. Develop the mathematical modelling equations of the system as shown in Fig. 3. Draw f-v analogous circuit. **(6)**

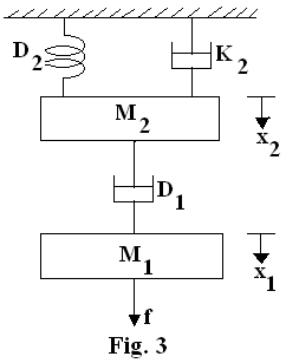


**Fig. 3**

**Q.3** a. Obtain the simplified block diagram representation of the system as shown in Fig. 4. **(8)**

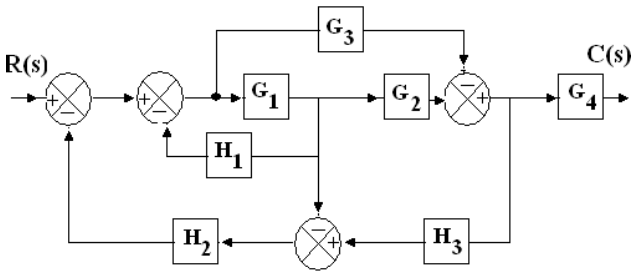


**Fig. 4**

b. Find the transfer function of the system as shown in Fig. 5 **(8)**

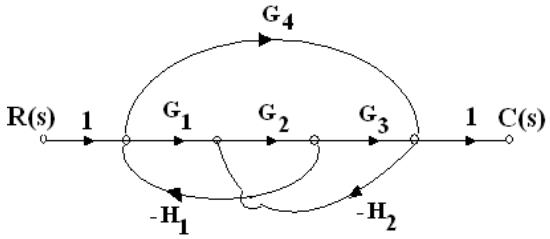


**Fig. 5**

**Q.4** a. Draw and explain with a neat sketch for time response of second order system. **(8)**

b. For system having $G(s)H(s)\dfrac{K(s+4)}{s(s^3+5s^2+6s)}$, find

(i) type of the system (ii) error coefficient

(iii) error due to input $\dfrac{A}{4}t^2$ **(8)**

**Q.5** a. Give the difference between feedback and Non-feedback systems. What beneficial effects in feedback systems with high loop gain? **(8)**

b. Consider the feedback control system shown in Fig.6. The normal value of process parameter K is 1. Evaluate the sensitivity of transfer function $T(s)=C(s)/R(s)$ to variations in parameter K. **(8)**

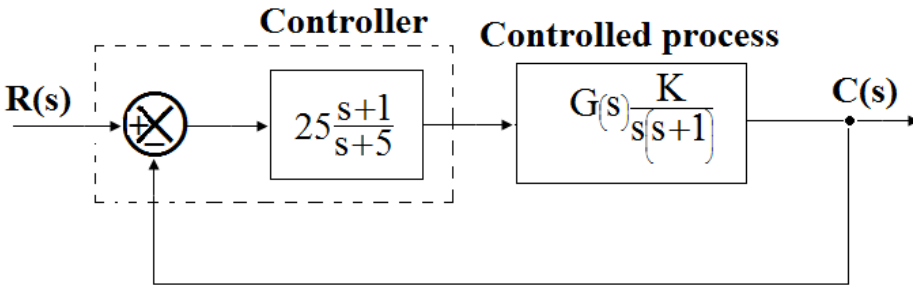


**Fig.6**

**Q.6** a. List the major steps involved in plotting of root-locus of a function. **(4)**

b. Sketch the root-locus for $G(s)H(s) = \frac{K}{S(S+1+j)(S+1-j)}, K > 0$ **(12)**

**Q.7** a. State advantages and limitations of frequency domain analysis **(4)**

b. Find 'K' and 'a' for the feedbacks system as shown in Fig.7, so that $M_r$ =1.25 and $\omega_r$ =12.65 rad/sec will be satisfied. Also determine the settling time and bandwidth. **(12)**

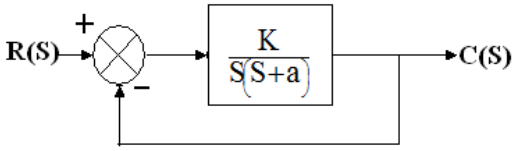


**Fig.7**

**Q.8** a. A unity feedback control system has open-loop $G(S) = \frac{K}{S(S+50)}$. Design a PI controller $G_c(s) = \frac{s+\alpha}{s}$ to meet the following specifications:

(i) $M_P = 20\%$ (ii) $t_s = 2\,\text{sec}$. **(10)**

b. Explain the requirement for network compensation. Briefly discuss the various compensation techniques. **(6)**

**Q.9** a. Write the properties of state transition matrix. **(4)**

b. 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 $\begin{bmatrix} x_1 \\ x_2 \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$ **(12)**