Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: B.Tech.

Branch	**: EEE,**	**Semester**	**: 4th**
Title of the Course	**: Control Systems**	**Course Code**	**: EEB 252**

Time: 3 Hours **Maximum Marks: 50**

Note : **1.** This question paper has 3 sections. Section A consists 10 parts of 1 mark each. Section B contains 5 questions of 5 marks each. Section C consists of 3 questions of 10 marks each.

2. All the symbols have their usual meaning. Make suitable assumptions wherever required.

Section A (All questions in this section are compulsory)

Q1. **i)** The impulse response of a system is observed to be e^{-2t}. Find the transfer function of the system.

ii) What do you understand by the impulse response of a system?

iii) Define open-loop transfer function of a system.

iv) The forward path transfer function of a unity negative feedback system is given by $\frac{10}{(3s+1)(10s+1)}$. Determine the open-loop transfer function.

v) In a negative feedback system, the overall gain of the system as compared to the gain of the forward path gain is _____ (more/less).

vi) The poles of a system with the transfer function $G(s) = \frac{s^2-49}{(s^5-7s^4-30s^3)}$ are located at _____.

vii) The steady-state error for a type-2 system subjected to a unit ramp input is _____.

viii) If $e(t)$ represents the error input to the controller and $m(t)$ represents the output of a controller, the input-output relation of a proportional control is given by _____.

ix) If a LTI system is subjected to a bounded input and the response has some oscillations which increase with time, then the system is said to be _____.

x) Each branch of the root-loci of the characteristic equation of a closed-loop control system terminates at _____.

Section B

(Answer any four (04) questions in this section)

Q2. Obtain the overall transfer function of the system represented by the block diagram shown in Fig. 1 by using the block diagram algebra.

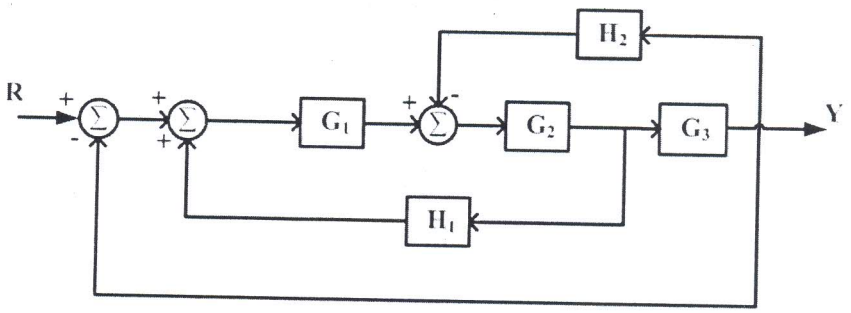

Fig. 1

Q3. What do you understand by frequency response? What are the various frequency response methods of analyzing the linear control systems?

Q4. Apply Routh-Hurwitz criterion to determine the stability of the feedback system with the following characteristic polynomial and determine the number of poles in the right-half plane.

$$2s^4 + s^3 + 3s^2 + 5s + 10$$

Q5. Consider a system whose output is given by $C(s) = \frac{64K}{s(s^2+8s+64)}$. Determine the following:

a) Damped natural frequency **b)** Peak time **c)** the output response $c(t)$ **d)** Maximum overshoot

Q6. Determine the position, velocity and acceleration error constants of a unity feedback control system with the forward path transfer function given by $\frac{k}{s^2(s+2)(s+12)}$.

Section C

(Answer any two (02) questions in this section)

Q7. Explain in detail the effects of feedback on

a) impulse response of a 1st-order system **b)** steady-state error of a system

Q8. A unity feedback system has the forward path transfer function as $\frac{K}{s(Ts+1)}$. The maximum overshoot in the unit-step response of this system is to be reduced from 60 % to 20 %. Determine the change in the factor K required to achieve the aforesaid reduction.

Q9. **a)** Determine the points of intersection of the root-loci of the following characteristic equation with the imaginary axis of the complex s-plane:

$$s^2 + 6s + K = 0$$

b) Determine the break-away points of the root-loci of a system whose characteristic equation is given by

$$1 + G(s)H(s) = 1 + \frac{K}{s(s+2)(s+4)^2} = 0$$