Roll No.:........................

National Institute of Technology, Delhi

Name of the Examination: B.Tech.

Branch	**: EEE,**	**Semester**	**: 4^{th}**
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)** 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 ____________.

ii) What are positive feedback systems?

iii) State the Mason's gain formula.

iv) Find the transfer function of the system whose dynamics is represented by

$$\ddot{y}(t) + 3\dot{y}(t)+2y(t) = \dot{x}(t) + x(t)$$

v) What is the relation between the transfer function and the impulse response of a system?

vi) A system has closed-loop poles on jw-axis which are not repeated. Comment on the stability of the system.

vii) The input to a system was withdrawn at $t = 0$. The output was found to decrease exponentially from 1000 units to 500 units in 1.386 seconds. What is the time constant of the system?

viii) Find the closed-loop poles of a unity-feedback system with the open-loop transfer function:

$$G(s) = \frac{4}{(s+2)^2}$$

ix) The sensitivity of output of an open loop system as compared to that of a closed loop system with respect to the parameters of forward path is less. True/False?

x) Define steady-state error of a control system.

Section B

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

Q2. The forward path of a unity feedback control system is given by $(s) = \frac{K}{s(s+6)}$. Obtain the output for $K = 8, 9$ and 13. Also, specify the form of the response obtained for each case.

P.T.O.

Q3. A unity-negative feedback system has a closed loop transfer function $\frac{5}{(2s+1)(7s+1)}$. Determine the forward path transfer function.

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.

$$s^5 + 2s^4 + 3s^3 + 6s^2 + 5s + 5$$

Q5. Determine the breakaway points of the root-loci of a system with the open-loop transfer function

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

Q6. Consider a unity-feedback system with the open-loop transfer function $(s) = \frac{K(s+a)}{s^2(s+b)(s+c)}$.

Determine the acceleration error constant and the steady-state error to the input

$$r(t) = (K_1 + K_2 t + K_3 t^2)u(t).$$

Section C

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

Q7. For a unity-feedback 2nd –order system with forward path transfer function $(s) = \frac{\omega_n}{s(s+2\xi\omega_n)}$,

explain the effect of PD control action with the transfer function $(1 + sT_d)$ on the

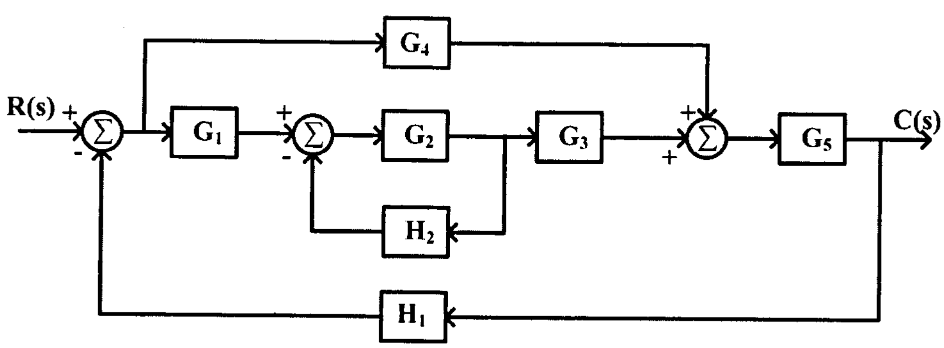
a) Peak overshoot **b)** steady-state error due to a ramp input.

Q8. Consider a unity-feedback control system with the open-loop transfer function $G(s) = \frac{K}{s(Ts+1)}$

A unit-step input is applied to this system. Determine the values of K and T so that the maximum percent overshoot is 20 % and the resonant frequency is 10 rad/sec. Also, calculate the following:

a) resonant frequency **b)** resonant peak

Q9. Consider the system represented by the following block-diagram:



a) Draw the signal flow graph for the above system.

b) Find the overall transfer function $\frac{C(s)}{R(s)}$ of the above system by using the Mason's gain formula.