National Institute of Technology, Delhi

Name of the Examination: B.Tech.

Branch   : EEE   Semester   : 5th

Title of the Course   : Control Systems   Course Code   : EE 301

Time: 3 Hours   Maximum Marks: 50

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

Section A

(All questions in this section are compulsory)

Q1. i) What do you mean by an open-loop control system?

ii) Why negative feedback is preferred in control systems?

iii) Define the term Impulse response of a system.

iv) Define controllability.

v) Does the transfer function of a system depend on the input?

vi) What is the use of Mason's gain formula?

vii) What is steady-state error?

viii) What do you mean by BIBO stability?

ix) Where does the root locus terminate?

x) Name two ways to plot the frequency response.

Section B

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

Q2. Obtain the open-loop transfer function for the system whose characteristic equation is:

$$s^3 + s^2 + (K + 2)s + 3K = 0$$

Q3. Determine the range of K for the feedback system with the following characteristic equation to be stable :

$$s^4 + 20s^3 + 15s^2 + 2s + K = 0$$

Q4. Find the breakaway points for the following loop function:

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

Q5. A unity negative-feedback system is characterized by an open-loop transfer function:

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

Determine the value of K so that the system will have a damping ratio of 0.5.

Q6. Obtain a state-space model of the system represented by the following transfer function:

$$\frac{Y(s)}{U(s)} = \frac{5}{(s^3+6s+7)}$$

Section C

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

Q7. Explain the effect of following control actions on the performance of a first-order system:

a) Proportional control

b) Integral control

c) Derivative control

d) Proportional plus derivative control

e) Proportional plus integral control   **(2+2+2+2+2 = 10 Marks)**

Q8. a) Derive an expression for the time response of a 2nd-order system excited by a unit-step input.

b) Using the result of part (a), derive expressions for rise time, peak time and peak overshoot.

(4+6 = 10 Marks)

Q9. A unit-step response test conducted on a 2nd-order system yielded peak overshoot $M_p = 0.12$, and peak time $t_p = 0.2$ s. Obtain the frequency response indices M_r (resonant peak), ω_r (resonant frequency) and ω_b (bandwidth).