Roll No.:.....

National Institute of Technology, Delhi

Name of the Examination: B. Tech.

End-Semester Examination April-May, 2019

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 consists of 3 sections: A, B and C. All the questions in section A are compulsory. Section B comprises of 5 questions (Q2 to Q6) out of which only 4 questions are to be attempted. Section C consists of 3 questions (Q7 to Q9) out of which only 2 questions are to be attempted.

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

SECTION A

Q1. **(i)** What is corner frequency in Bode plot?

(ii) A negative feedback system has a forward gain of 10 and a feedback path gain of 1. The close-loop gain of the system is _____.

(iii) The characteristic equation of a closed-loop system is $s^2 + 2s + 2 = 0$. The system is _____ (overdamped/critically damped/underdamped).

(iv) Define type of the system.

(v) Define breakaway point in a root locus.

(vi) What is BIBO stability?

(vii) Write one disadvantage of the proportional control.

(viii) Bode plot can be used to obtain the transfer function of a system. True/False?

(ix) According to the Nyquist stability criterion $Z = N - P$. True/False?

(x) What is Nyquist path?

SECTION B

Q2. The closed-loop transfer function of a system is found to be $T(s) = \frac{1}{Ps^2+Qs+R}$. On the application of a step input of 10 units, it is observed that the maximum overshoot is 6 %, peak time is 1 sec and the steady-state value of the output is 0.5 rad. Determine P, Q and R.

Q3. The open-loop transfer function of a system with unity-feedback is $G(s) = \frac{10(s+2)(s+3)}{s(s+1)(s+4)(s+5)}$. Determine the steady-state error when the system is subjected to the input $u(t) = 3 + t + t^2$.

Q4. What is the geometrical shape of the root-locus of the system $G(s)H(s) = \frac{K(s+b)}{s(s+a)}$. Prove your answer.

Q5. Investigate the stability of a system using Routh's criterion when the characteristic equation of the system is $s^5 + 2s^4 + 3s^3 + 6s^2 + 10s + 15 = 0$.

Q6. Determine the overall transfer function for the system shown in Fig. 1 by using block diagram algebra.

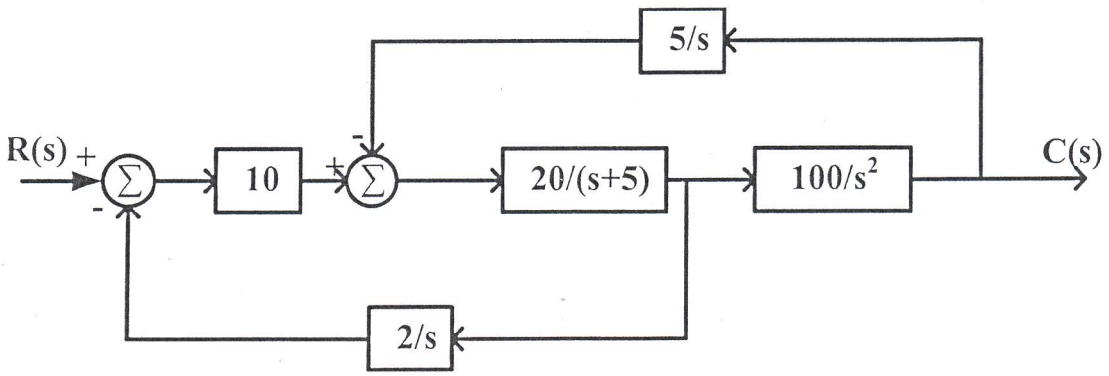

Fig. 1

SECTION C

Q7. Assuming the magnitude of the system at zero frequency as 1, derive the expressions for the following in terms damping ratio and natural frequency of the system.

(a) Resonant frequency

(b) Resonant peak

(c) Bandwidth

Q8. Write the transfer function, advantages and disadvantages of the following controllers:

(a) Proportional-Integral controller

(b) Proportional-Derivative controller

Q9. The response of a system with the transfer function $G(s) = \frac{1}{(s+1)(s^2+s+1)}$ to the input $u(t) = (1 + e^{-3t} - e^{-t})$ is given as follows:

$$y(t) = A + Be^{-t} + C\ sin\frac{\sqrt{3}}{2}te^{-t/2} + D\ cos\frac{\sqrt{3}}{2}te^{-t/2} + Ee^{-3t}$$

Determine A, B, C, D and E.