National Institute of Technology, Delhi

Name of the Examination: Mid Semester Examination (Spring Semester 2022)

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

Date of Examination: 08.03.2022 **Time: 1.5 Hours** **Maximum Marks: 25**

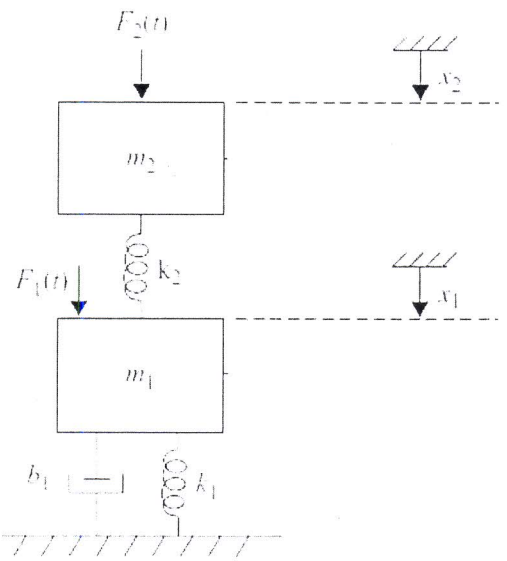
Note: 1. All the 5 questions are compulsory.

2. The symbols used have their usual meaning. Make suitable assumptions wherever necessary.

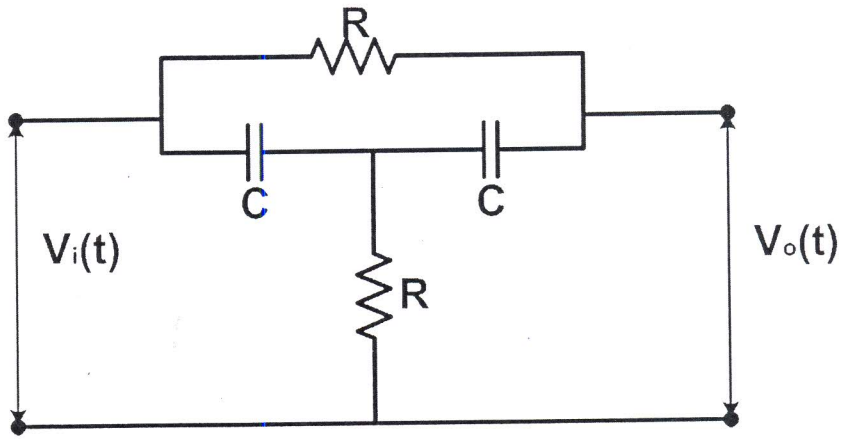
Q1. Using Routh's stability criterion, determine whether the system with characteristic equation given below is stable or not. **[6M]**

$$s^6 + s^5 + 4s^4 + 4s^3 + 5s^2 + 4s + 2 = 0$$

Q2. Obtain the transfer functions $\frac{X_1(s)}{F_1(s)}$ and $\frac{X_2(s)}{F_2(s)}$ for the system shown below. **[5M]**



Q3. Draw signal-flow graph for the network shown next and obtain the transfer function $\frac{V_0(s)}{V_i(s)}$ by applying the Mason's gain formula. **[5M]**



Q4. Consider a unity-feedback system with open-loop transfer function given by

$$G(s) = \frac{15}{(s+1)(s+3)}$$

The system is subjected to a unit-step input. Find the following:

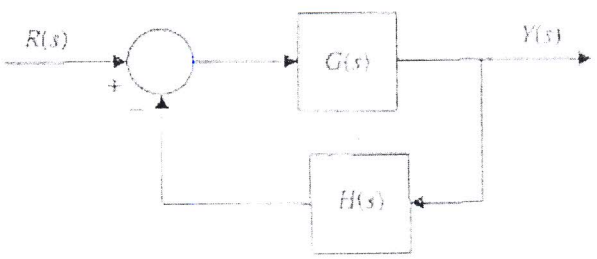
(a) ω_n and ξ.

(b) Time at which the first undershoot occurs.

(c) Number of cycles of output response before settling down according to 2% criterion.

[1 + 1 + 2 = 4M]

Q5. Consider the feedback system shown below. **[5M]**



The sensitivity of overall transfer function $T(s)$ with respect to variation in the transfer function $H(s)$ is given by

$$S_H = \frac{d\,T(s)/\,T(s)}{d\,H(s)/\,H(s)}$$

Let

$$G(s) = \frac{100}{s(s+1)}$$

and $H(s) = 50$. Determine the sensitivity of the closed-loop transfer function with respect to $H(s)$ at $\omega = 2$ rad/sec.