VIT
Vellore Institute of Technology

Final Assessment Test – November 2019

Course: ECE2010 - Control Systems
Class NBR(s): 1118 / 1534 / 1543
Time: Three Hours

Slot: F1+TF1
Max. Marks: 100

KEEPING MOBILE PHONE/SMART WATCH, EVEN IN 'OFF' POSITION, IS EXAM MALPRACTICE

***General Instructions:* Use appropriate graph sheets for solving Bode plot/Polar plot/Root locus problems**

Answer ALL Questions

1. During a medical operation an anesthesiologist controls the depth of unconsciousness by controlling the concentration of isoflurane in a vaporized mixture with oxygen and nitrous oxide. The depth of anesthesia is measured by the patient's blood pressure. The anesthesiologist also regulates ventilation, fluid balance, and the administration of other drugs. In order to free the anesthesiologist to devote more time to the latter tasks, and in the interest of the patient's safety, we wish to automate the depth of anesthesia by automating the control of isoflurane concentration. Draw a functional block diagram of the system showing pertinent signals and subsystems. [6]

2. Using D' Alembert's principle, determine the transfer function $\frac{X_1(s)}{F(s)}$ for the following mechanical translational system as shown in figure 1. [10]

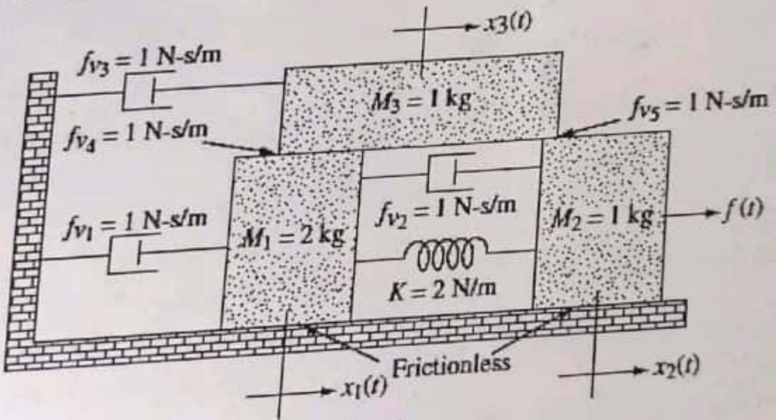

Fig. 1

3. Find the transfer function $C(s)/R(s)$ by using Masons gain formula for the signal flow graph as shown in the fig. 2. [10]

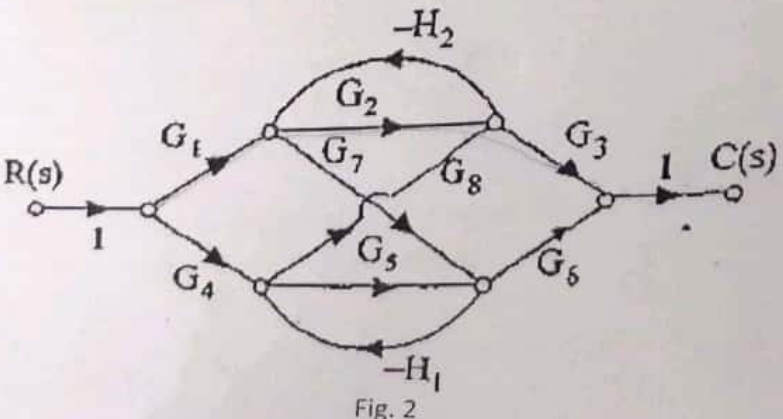

Fig. 2

SEARCH VIT QUESTION PAPERS
ON TELEGRAM TO JOIN

4. Determine the value of K and P of the closed-loop system shown in figure 3, so that the maximum overshoot in the unit step response is 25% and the peak time is 2 seconds. Assume that $J = 1$ kg-m^2. [10]

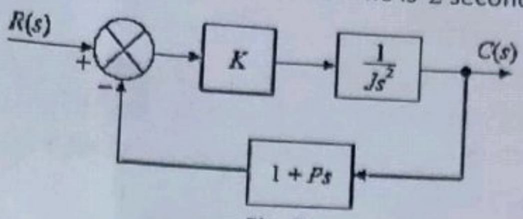

Fig. 3

5. Sketch the root locus for the unity feedback control system, whose open-loop transfer function is given by $G(s)H(s) = \dfrac{K(s+0.5)}{s^2(s+12)}$. Determine the following: [12]

a) The breakaway point/break-in point
b) The intersection of root locus with $j\omega$ axis

6. Construct the Bode plots on a semi-log graph paper for a unity feedback system whose open-loop transfer function is given by $G(s)H(s) = \dfrac{10(1+0.1s)}{s(1+0.5s)(0.2s+1)}$ [12]

From the Bode plot determine the following:
a) Gain and phase cross over frequencies
b) Gain and phase margin,
c) Comment on the stability of the system.

7. The open-loop transfer function of a unity feedback system is given by [10]
$G(s) = \dfrac{(1+0.2s)(1+0.025s)}{s^3(1+0.005s)(0.001s+1)}$. Sketch the polar plot.

8. The open-loop transfer function of a unity feedback system is given by $G(s) = \dfrac{5}{s(1+2s)}$. Find the phase margin of the uncompensated system using bode plot technique. If a phase lag element with transfer function $\dfrac{(1+20s)}{(1+200s)}$ is added in the forward path, determine the phase margin and new gain cross over frequency of the compensated system. [10]

9. Consider a unity feedback system has an open loop transfer function $G(s) = \dfrac{1}{s(s+1)}$. Design a PD controller so that the phase margin of the system is 30° at a frequency of 2 rad/sec. [10]

10. Given the state equation and the output equation of the system in which x_1, x_2 and x_3 constitute the state vector. Determine whether the system is completely controllable and observable. [10]

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \\ \dot{x}_3 \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix} + \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix} u(t) \text{ and } y = \begin{bmatrix} 10 & 5 & 1 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \end{bmatrix}$$