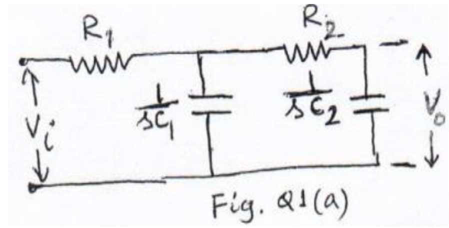
Birla Institute of Technology and Science, Pilani
Second Semester 2022-2023
ECE/EEE/INSTR F242: Control Systems
Comprehensive Examination (closed Book)

Date: May 11th, 2023 **Time: 2 Hrs** **MM: 60**

Q1. For the network shown in figure Q1 (a):



i) Write down the governing equations and determine the transfer function $\frac{V_o(s)}{V_i(s)}$

ii) Determine the value of C_2 for damping ratio to be 2 and corresponding value of natural frequency of oscillations. In case of multiple solutions, which one would you choose and why? (take $R_1=R_2=2\ \Omega$ and $C_1=0.5F$)

iii) Now, if G(s) represents the transfer function $\frac{V_o(s)}{V_i(s)}$ in the figure Q1(b), calculate the gain margin and phase margin of the system.

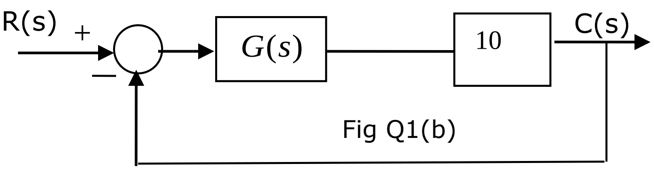


Fig Q1(b)

iv) Determine the value of steady state error for an input of $(2+e^{-t})\,u(t)$ in case of (iii)

[16]

Q2. The open loop transfer function of a negative feedback system is $\frac{K}{s(s+1)(0.1s+1)}$.

Sketch the Bode plots (take K=1 in the beginning) and therefrom determine the values of K for (i) gain margin to be 15 db and (ii) Phase margin to be 60° and (iii) system to be marginally stable. *Start your plots at ω =0.1 rad/s in the semi-log graph sheet provided.* [16]

Q3. The forward path transfer function of a unity feedback system is given by $\frac{K(s+4)(s+3)}{s(s-3)(s+8)}$. Draw the Nyquist plot, apply Nyquist stability criterion to determine the stability of the closed loop system and number of unstable closed loop poles. [16]

Q4. For the mechanical system shown below, write down the equations of motion and therefrom assuming position and velocities as the states, obtain a state space representation of the system. Consider x_1 and x_2 as the outputs and F_1 and F_2 as inputs. (Assume that mass m_2 is connected to the hinge with a massless rod.) [12]