Reg. No.									

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

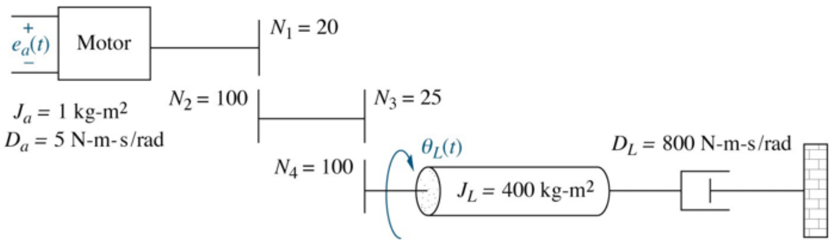
IV SEMESTER B. TECH (ELECTRICAL & ELECTRONICS ENGINEERING)
END SEMESTER EXAMINATIONS, MAY 2024

LINEAR CONTROL THEORY [ELE 2223]
REVISED CREDIT SYSTEM

Time: 3 Hours **Date: 11 MAY 2024** **Max. Marks: 50**

Instructions to Candidates:
- Answer **ALL** the questions.
- Missing data may be suitably assumed.

1A. Determine the transfer function $G(s) = \dfrac{\theta_L(s)}{E_a(s)}$ of the motor with load shown in figure, torque speed characteristics is given as $T_m = -8\omega_m + 200$ when the input voltage is 100 volts.



(04)

1B. Analyse the stability of the system with open loop transfer function $G(s)H(s) = \frac{K\,(s^2+2s+10)}{(s^2+4s+5)}$ using Root locus. Clearly mention all the steps. ***(04)***

1C. The open loop transfer function of a unity feedback system is $G(s)H(s) = \frac{10}{(s+2)(s^2+4s+3)}$, solve for the finite steady state error constant. ***(02)***

2A. The open loop transfer function of a Floppy drive system consisting of motor and load is given by $G(s)H(s) = \frac{3(2-s)}{(s+1)(s+5)}$ i) Draw the Nyquist plot ii) Determine the gain margin iii) Mark phase margin on the plot iv) Analyse the stability of the system. ***(04)***

2B A servo mechanism with unity feedback, has the open loop transfer function $G(s) = \frac{K}{(s+1)(s+3)(s+10)}$. Design a PI controller satisfying the damping ratio of 0.517 and damped frequency of oscillation 2.6 rad/sec. Find the gain K of the compensated system. ***(04)***

2C. For a second order under damped system, the natural frequency of oscillation is 10 rad/sec, and the settling time is 1 sec, determine the dominant poles of the system. ***(02)***

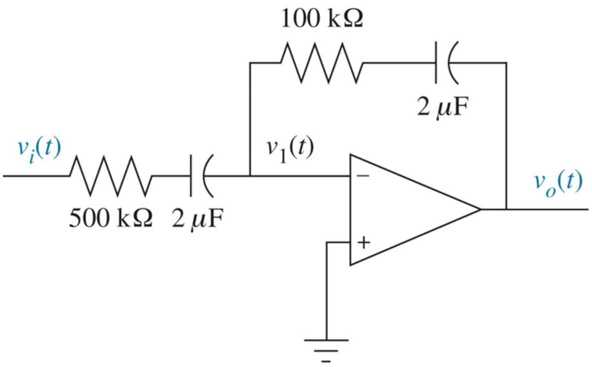
3A. Design a stable PID controller in the form

$$K\frac{(s+a)^2}{s}$$

using Zeigler – Nichols tuning method for the plant with transfer function

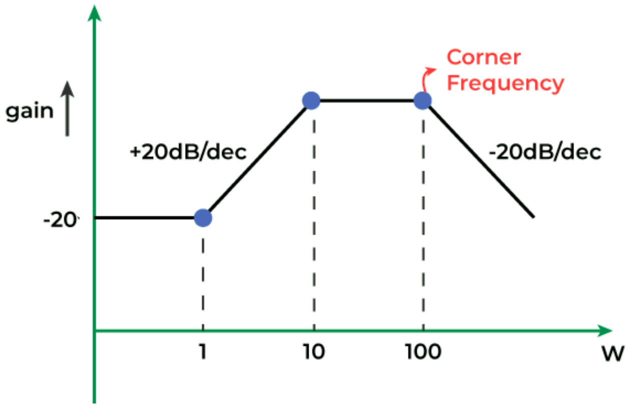
$$G(s) = \frac{K}{s(s^2+10s+36)}$$ ***(04)***

3B Identify the controller realized using Active circuit by deriving its transfer function.



(03)

3C. For the bode magnitude plot shown in figure, determine the transfer function.



(03)

4A The open loop transfer function of a magnetic levitation control system can be represented by the unity feedback system with plant transfer function

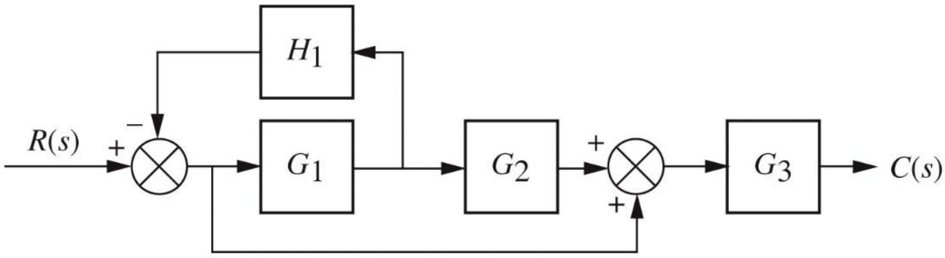
$$G(s)H(s) = \frac{5}{s(s+1)(0.5s+1)}$$

Design a lag compensator using frequency domain methods so that the compensated system has a phase margin of 40°. (Use frequency response analytical method). What is the steady state error of the compensated system.

Note: Uncompensated system is unstable. ***(05)***

4B. Distinguish the concept and function of PI and PD controller. ***(02)***

4C. For the block diagram given, obtain the signal flow graph and determine the transfer function using Mason's gain formula.

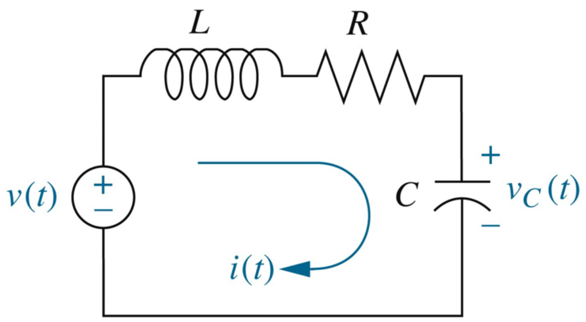


(03)

5A. Determine the state model in physical variable form of an armature voltage-controlled DC motor used for solar photo voltaic application. Take Armature current (i_a) and angular velocity ($\frac{d\theta}{dt}$) as the state variables and output as angular displacement (θ). ***(04)***

5B. For the given RLC circuit, taking Inductor current and capacitor voltage as the state variables and capacitor voltage as the output, determine the state model in physical variable form.

R=10 Ω, L=1H, C=0.1 μF



(03)

5C. Explain the procedure for deriving lead compensator for a given specification. ***(03)***