TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2083 Baishakh

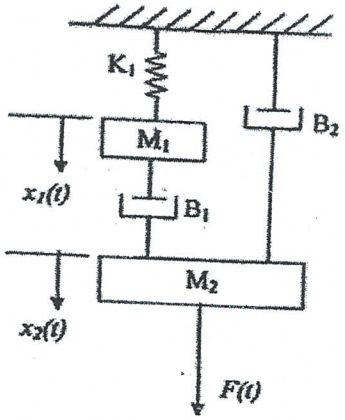
Exam.	Back (New Course)		
Level	BE	Full Marks	60
Programme	BEL	Pass Marks	24
Year / Part	II / II	Time	3 hrs.

Subject: - Control System (*ENEE 251*)

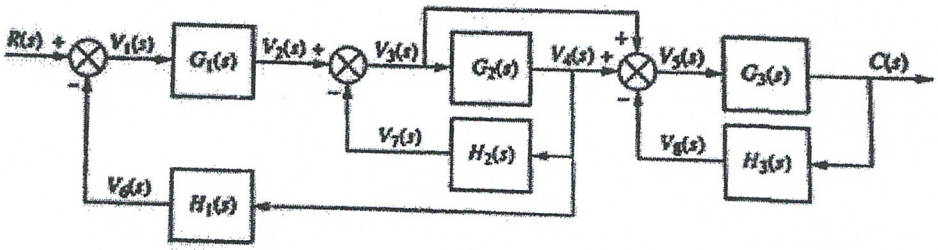
- ✓ *Candidates are required to give their answers in their own words as far as practicable.*
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is control system? Draw the block diagram of a closed loop control system and briefly explain the function of each block. [4]

   b) Derive the transfer function $X_1(s/F(s))$ for the system shown below. Also draw the F-V and F-I analogy circuit of the system. [8]



2. a) Obtain the overall transfer function C(s)/R(s) using block diagram reduction technique for the system represented by the block diagram as shown in the figure below. [6]



   b) A system having a forward path transfer function G(S) = 16/s(s+1) and unity feedback. Determine the value of undamped natural frequency, damping ratio. If tachometer feedback is introduced, the feedback path, transfer function becomes (1+Ks). What should be the value of K to obtain damping ratio of 0.6? Also calculate the percentage peak overshoot, first undershoot, peak time and settling time within 2 % of final value. [6]

3. a) The open loop transfer function of unity feedback control system is given by: [4]

$$G(s) = \frac{K}{(s+2)(s+4)(s^2+6s+25)}$$

   Using RH Criterion, determine the range of gain K, for the system to be stable

   b) Draw the root locus for a system whose open loop transfer function is given by: [8]

$$G(s)H(s) = \frac{K}{s(s+4)(s^2+5s+20)}$$

4. a) Using Nyquist criterion, determine the stability of the feedback system whose open loop transfer function is given by: [6]

$$G(s)H(s) = \frac{s+5}{(s-2)(s+2)}$$

Also, find the gain margin.

b) For $G(S) = \frac{K}{S(S+2)(S+10)}$, determine the value of K so that is stable with GM = 6 dB [6]

5. a) The open-loop transfer function of a unity feedback control system is given by: [8]

$$G(s) = \frac{K}{s(1+0.2s)}$$

Design a lead compensator such that velocity error constant, Kv = 10 and phase margin = 50 degrees.

b) Determine the transfer function from the state space model given below: [4]

$$\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t) + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u(t)$$

$$y(t) = [1 \quad 0]\, x(t)$$

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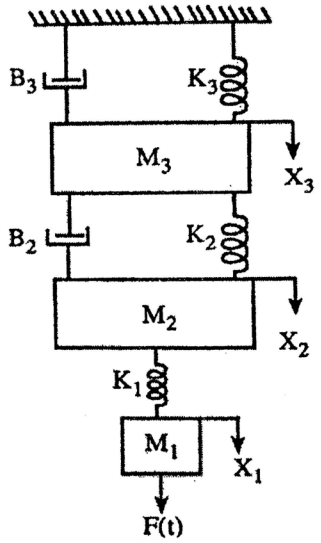
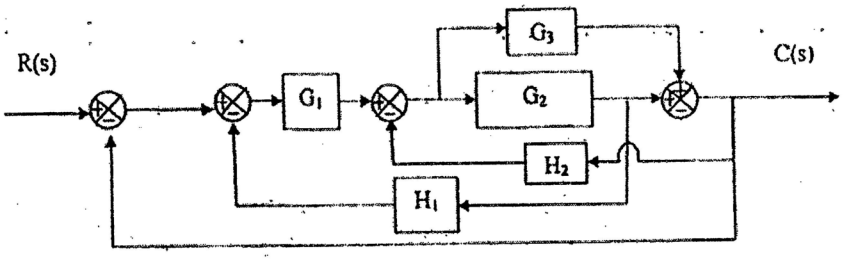
1. a) What is open and closed loop control system? Discuss along with their advantages and disadvantages. [6]

   b) Obtain the mathematical equations for the mechanical system shown in figure. Also obtain the force-current analogy. [6]

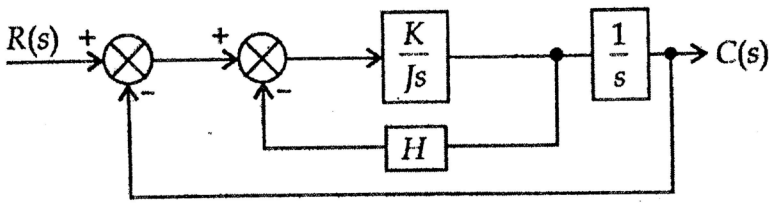


2. a) Find overall transfer function of the system as shown below by block diagram reduction technique. [6]



   b) Determine the block diagram and transfer function of armature-controlled DC motor. [6]

3. a) Determine the value of 'K' and 'H' of the closed loop system so that maximum overshoot in unit response is 25% and the peak time is 2 sec. Assume J = 1 kg-m^2. [6]



b) The open loop transfer function of a unity feedback system is given by [6]

$$G(s) = \frac{K}{s(1+0.4s)(1+0.25s)}$$

Using Routh-Hurwitz criterion,

i) Determine the range of K so that the system is stable.

ii) Calculate the frequency at which the system will exhibit sustained oscillation.

4. a) Using Nyquist criterion, determine the stability of the feedback system whose open loop transfer function is given by : [5]

$$G(s)H(s) = \frac{s+5}{(s-2)(s+2)}$$

Also find the gain margin.

b) Sketch the polar plot for the following open loop transfer function and using Nyquist criterion, determine whether the system is stable or not. [6]

$$G(s)H(s) = \frac{60}{(s+1)(s+2)(s+5)}$$

5. a) Design a lead compensator for a system whose open loop transfer function is given by: [9]

$$G(s) = \frac{K}{s(1+0.1s)(1+0.001s)}$$

To meet the following specifications

Phase Margin (P.M.) ≥ 45

Velocity error constant K_v=1000 sec^{-1}

b) A system has the transfer function Y(S) / U(S) = 2 / (S^3+6S^2+11S+6). Find the state and output equation in matrix form. [4]

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