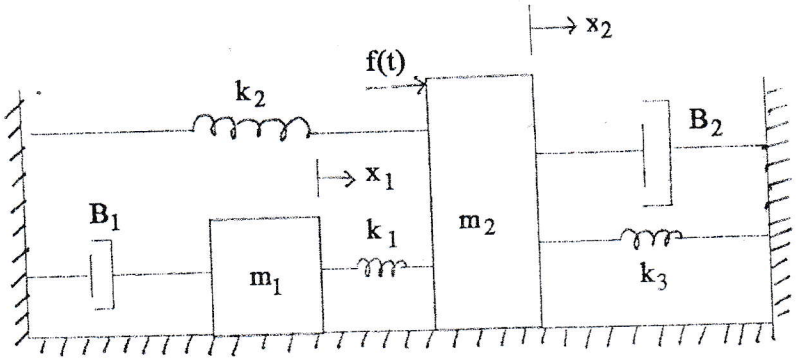
TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2080 Baishakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEI, BAS	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

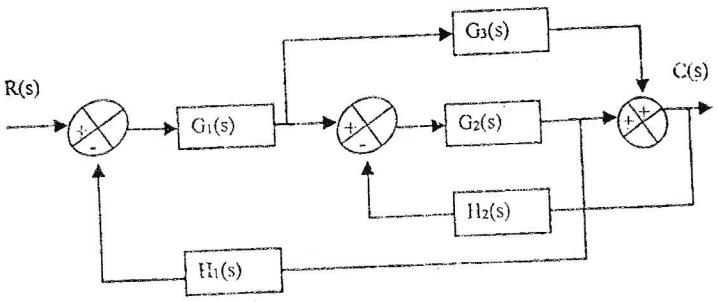
Subject: - Control System *(EE504)*

- ✓ 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) Draw the block diagram of closed loop control system and briefly explain each component. [5]
   b) How feedback effect the stability of a control system? Explain with suitable example. [3]
   c) Explain PID controller with block diagram and its transfer function, along with its characteristics. [6]
2. a) Find the transfer function of mechanical system given below taking output as velocity of mass M_2 also draw F-V and F-I analogy electrical networks. [8]



b) Using block diagram reduction technique, find the tr. Function $\frac{C(s)}{R(s)}$ of the fig given below. [8]



3. a) What is the importance of error coefficients in design of control system? For a unity feedback system having $G(s) = \frac{k(s+2)}{s^2(s^2+7s+12)}$, determine [6]

(i) Type and order of the system

(ii) Error coefficients and

(iii)Steady state error for parabolic input $r(t) = 2.5\ t^2$

b) Check for stability of the system using R-H Criterion whose characteristic equation is given by: [6]

$$q(s) = s^5 + 2s^4 + 2s^3 + 4s^2 + s + 2 = 0$$

Also Determine the number of poles in R-H plane and in imaginary axis.

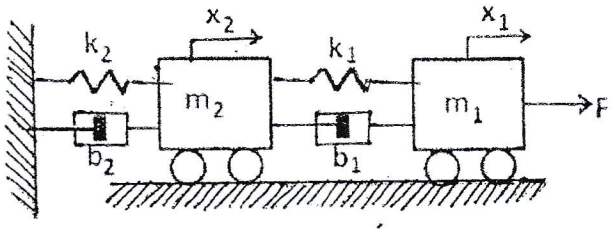
4. a) The open loop transfer function of a control system is given by

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

Sketch the root locus for $0 \le K \le \infty$ and determine the breakway point, the angle of departure from complex poles and the stability conditions. [10]

b) What is Nyquist Contour? Map the Nyquist contour of open loop transfer function $G(s) = \frac{300}{(S+3)(S+1)(S+2)}$ into G(s) plane and apply Nyquist criterion to check the stability of closed loop system. [8]

5. a) Obtain a state-space representation of the mechanical system shows in the figure where external force F is the input and the displacements of the masses x_1 and x_2x_1 and x^2 are the outputs. [8]



b) Design a suitable lag compensating network for $G(S) = \frac{k}{s(s+2)(s+20)}$ to meet the following specification. [12]

$Kv = 20Sec^{-1}$

$P.M \ge 35°$

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Bhadra

Exam.	**Regular**		
Level	BE	**Full Marks**	80
Programme	BEI, BAS	**Pass Marks**	32
Year / Part	II / I	**Time**	3 hrs.

Subject: - Control System *(EE 504)*

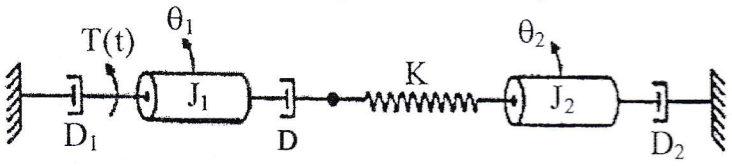
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define control system. Draw the block diagram of closed loop control system and explain the role of each block briefly. [1+4]

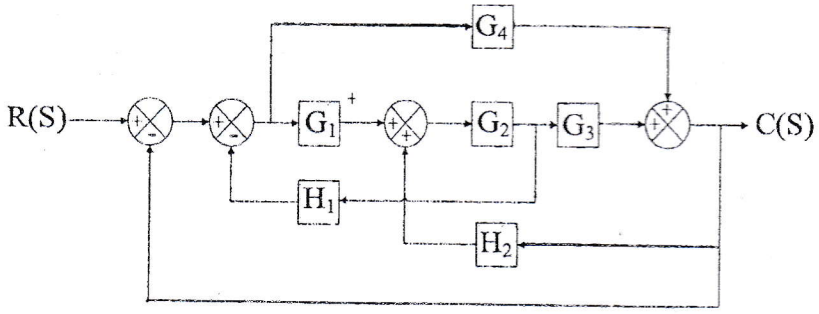
   b) Why closed loop system is faster than open loop control system? Explain. [3]

   c) What is derivative feedback controller? Draw block diagram and find the transfer function and hence show its effect on transient performance of the system. [6]

2. a) Find the transfer function, $\frac{\theta_2(S)}{T(S)}$, for the mechanical rotational system of figure below. Also draw the T-V and T-I analogy circuit of the system. [8]



   b) Determine the transfer function C(s) / R(s) of the block diagram given below, using block diagram reduction technique. [8]



3. a) Using R-H criteria, tell how many roots of polynomial is in right half s-plane, in left half s-plane and on jw axis. Comment on stability. [8]

   $S^5 + 4S^4 + 2S^3 + 8S^2 + S + 4 = 0$

   b) The open loop transfer function of a unity feedback system is given by:

$$G(S)H(S) = \frac{K}{S(1+ST)}$$

   Where, K is gain constant and T is time constants. With the gain multiplied by a factor K_1 the maximum overshoot of the system is increased from 25% to 50%. Determine K_1. [6]

4. a) Sketch the root locus of unity feedback system with $G(s) = \frac{k(s-4)}{(s^2+6s+18)}$, hence find the range of parameter k for stability of the closed loop system. Does the system exhibit sustained oscillation for any value parameter k? [8]

b) The open loop transfer function of a system is $G(s)H(s) = \frac{1+4s}{s^2(1+s)(1+2s)}$. Determine the stability of open and closed loop system using Nyquist Criterion. [8]

5. a) A system is characterized by the equation

$$\frac{Y(S)}{U(S)} = \frac{20(4s+2)}{s^3+5s^2+8s+2}$$

Find its state and output equation and express in matrix form. [8]

b) The forward path transfer function of unity feedback system is given by $G(s) = \frac{K}{s(s+10)(s+2)}$. Design a suitable location of pole zero pair for a lead compensating network so that phase margin is at least 50° and velocity error constant is maintained at least 800 sec^{-1}. [12]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI, BAS	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

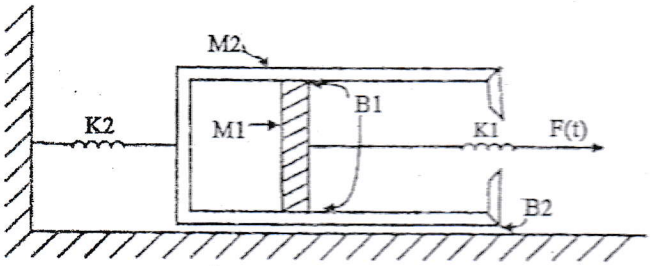
Subject: - Control System *(EE 504)*

- ✓ 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**.*
- ✓ ***Semi log/ Graph paper will be provided.***
- ✓ *Assume suitable data if necessary.*

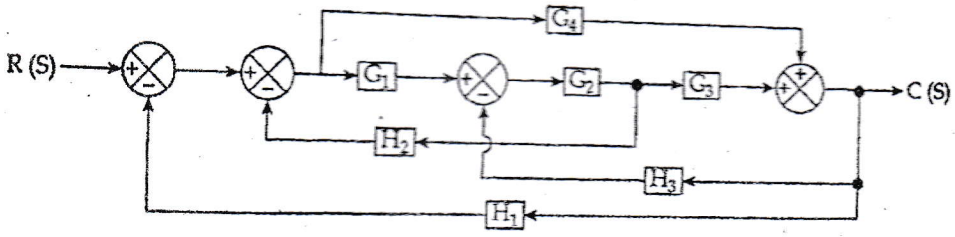
1. a) As a control engineer, you are required to control the actuator of a rotating system to get constant speed. Which type of control system will you suggest and why? [5]

   b) Discuss the effect of feedback on time constant of a control system. [3]

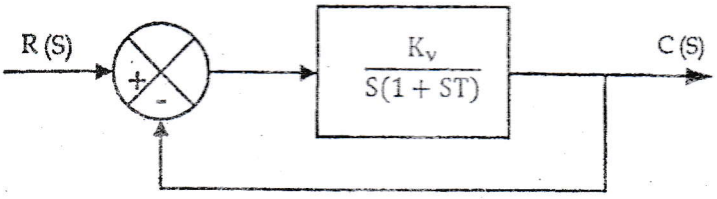
   c) Find Transfer function and develop F-V and F-I analogous circuits of the following figure. [8]



2. a) From the given block diagram, find the transfer ratio $\frac{C(S)}{R(S)}$ using block diagram reduction method. [8]



   b) A servomechanism as shown in block diagram below is designed to keep a radar antenna pointed at a flying aeroplane. If the aeroplane is flying with a velocity of 600 km/hr, at a range of 2 km and the maximum tracking error is to be within 0.1°, determine the required velocity error coefficient. [4]



   c) A system has 25% overshoot and settling time of 6 seconds, for a unit step input. Determine the transfer function and Calculate peak time. Assume e_{ss} as 2%. [4]

3. a) The characteristic equation of the system is $s^3 + 9s^2 + sK + K = 0$. Sketch the complete root locus and comment on stability. [8]

b) A system is described by the following equations:

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

$$y(t) = \begin{bmatrix} 1 & 2 \\ 1 & 0 \\ 1 & 1 \end{bmatrix} x(t)$$

Find the transfer function of the system and identify if the system is stable. [8]

4. a) What is relative and absolute stability? Check the stability of system with characteristics equation: $S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$ using R-H criteria. [2+6]

b) Using Nyquist criteria, determine the stability of the feedback system whose OLTF is given by: [8]

$$G(s).H(s) = \frac{1}{s^2(1+2s)(1+s)}$$

5. a) In response to unit ramp input, discuss role of derivative feedback controller for a second order system. [4]

b) The open loop transfer function of type-II system with unity feedback system is given by $G(S) = \frac{K}{S^2(1+0.25\,S)}$ Design a lead compensator to meet the following specifications.

(i) Acceleration error Constant (K_a) = 10/sec^2
(ii) PM at least 35° [12]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Kartik

Exam.	Back		
Level	BE	Full Marks	80
Programme	BEI, BAS	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

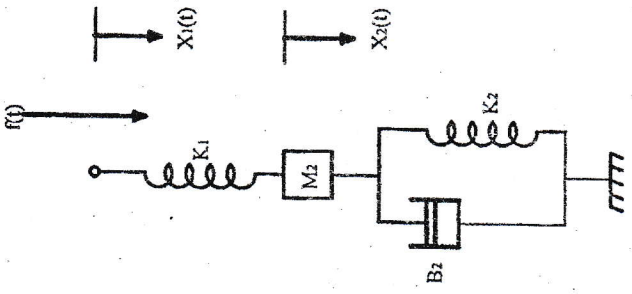
Subject: - Control System *(EE 504)*

- ✓ 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**.*
- ✓ ***Semi log/ Graph paper will be provided.***
- ✓ *Assume suitable data if necessary.*

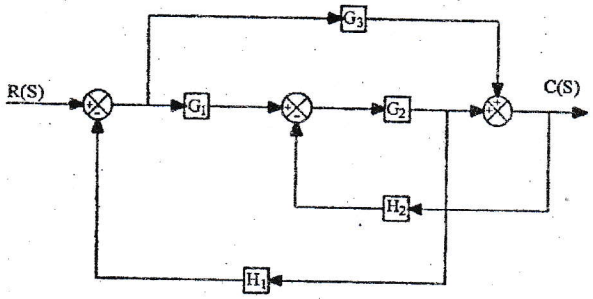
1. a) Stating an example of a system that you see in your field of study, explain what do you understand by closed loop system and its importance. [5]

   b) Why closed loop system is faster than open loop control system? Describe with necessary mathematical expressions. [3]

   c) Find transfer function for the system as in figure. Also develop F-V and F-I analogy circuits. [4+2+2]



2. a) Find overall transfer function of the following diagram using block diagram reduction technique. [8]



   b) The system below in figure (a) when subjected to unit step input; the output response is as shown in the figure (b). Determine the value of K and T. [8]

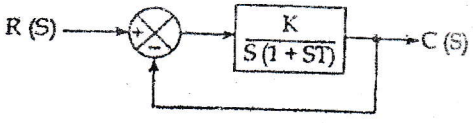


Figure: (a)

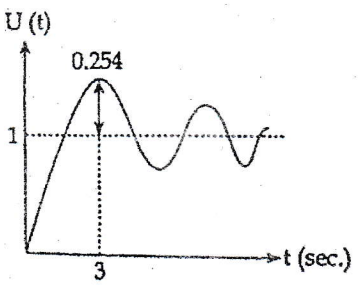
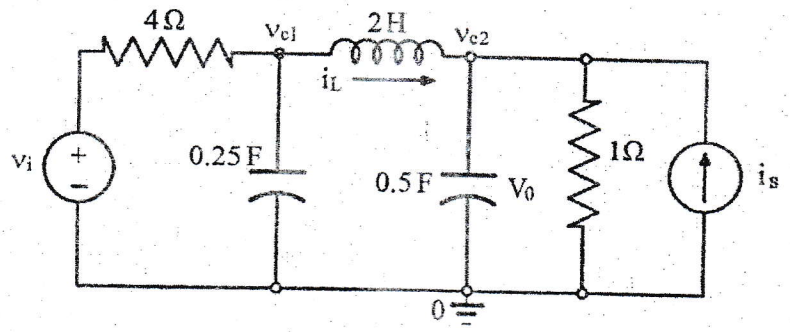


Figure: (b)

3. a) For a unity feedback system the OLTF of a control system is given by $G(S) = \frac{K}{S(S+4)(S^2+4S+20)}$; Sketch the root locus for $0 \leq K \leq \infty$ and determine the breakaway point, the angle of departure from complex poles and the stability conditions. [10]

b) Find state space representation of the system. [6]



4. a) The characteristics equation of a feedback control system is [8]

$$S^4 + 20S^3 + 15S^2 + 2S + K = 0$$

(i) Determine the range of K for the system to be stable.

(ii) Can the system be marginally stable? If so, find the required value of K and the frequency of sustained oscillation.

b) Sketch polar plot, determine Gain Margin, phase margin and comment on stability for a unity feedback system with feed forward transfer function $G(S) = \frac{10}{S(S+1)^2}$. [8]

5. a) There exists a permanent mismatch actually to track the reference by the actual system. Suggest a wayout to follow your system as per reference and justify. [4]

b) Design a suitable phase lag compensating network for $G(S) = \frac{K}{S(1+0.1S)(1+0.2S)}$ to meet the following specifications: $K_v = 30\ sec^{-1}$ $P.M \geq 40°$ [12]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2076 Chaitra

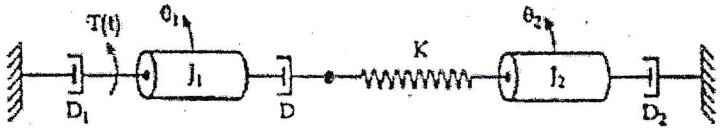
Exam.	Regular		
Level	BE	Full Marks	80
Programme	BEI, BAS	Pass Marks	32
Year / Part	II / I	Time	3 hrs.

Subject: - Control System *(EE 504)*

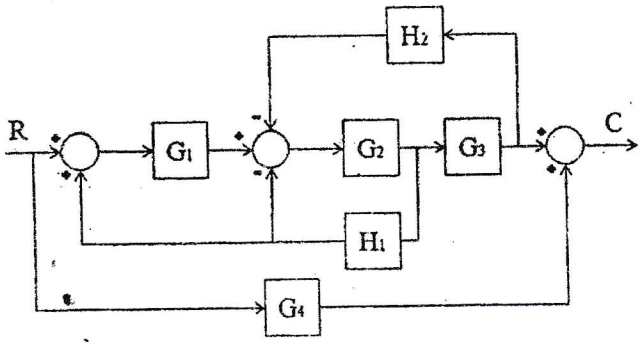
- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What is control system? "When feedback is added on a control system, it's response is faster." Illustrate this statement mathematically. [2+6]

   b) Find the transfer function, $\frac{\theta 2(S)}{T(S)}$, for the mechanical rotational system of figure below. Also draw the T-V and T-I analogy circuit of the system. [8]



2. a) Determine the transfer function C/R for the block diagram below by signal flow graph (SGF) techniques. [8]



   b) The open loop TF a unity feedback control system is given as

$$G(S) = \frac{k}{s(s^2+s+1)(s+2)+k}$$

   Determine the range of gain k for the system to be stable. Also determine the value of k which will cause the sustained oscillation and corresponding oscillation frequency. [5+3]

3. a) The open loop transfer function of a control system is given by

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

   Sketch the root locus for $0 \le K \le \infty$ and determine the breakaway point, the angle of departure from complex poles and the stability conditions. [10]

   b) Write short notes on followings: [3+3]

   (i) Characteristics of PI and PD control actions
   (ii) Nyquist stability criterion

4. a) Sketch the polar plot of the system whose open loop transfer function is given by

$G(S)H(S)=\frac{1}{s(1+s)(1+2s)}$. Also comment on stability. [8]

b) Discuss the advantages and limitations of state space analysis of control systems. Find the transfer function for the system represented by following state space model. [2+6]

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

$$y=\begin{bmatrix}1 & 0\end{bmatrix}x$$

5. Design a suitable lead compensating network for $G(S)=\frac{k}{s^2(1+0.25s)}$ to meet the following specification [16]

$K_a = 10\ \text{sec}^{-1}$

$P.M \geq 35°$

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