Code: 9A02503

R09

B.Tech III Year I Semester (R09) Supplementary Examinations December 2015

CONTROL SYSTEMS

(Common to EEE, E.Con.E, EIE, ECE and MCT)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

(Polar graphs may be permitted in the examination hall)

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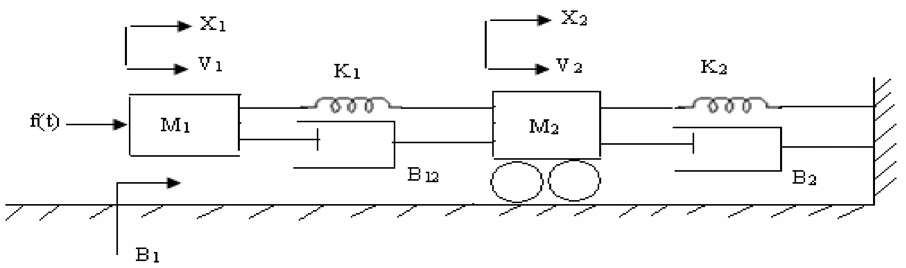
1 (a) Explain the feedback characteristics of a closed loop control system

(b) Write the differential equations governing the mechanical system shown in figure below.



2 Derive the transfer function for the field controlled D.C servomotor with neat sketch.

3 (a) What is meant by time response? Explain about: (i) Steady-state response. (ii) Transient response.

(b) Obtain the response of unity feedback system whose open loop transfer function is G(s) = 4/s(s+1) when the input is unit step.

4 Sketch the root locus of the following unity feedback system with:

$G(s) = K/(s(s+2)(s^2+2s+4))$

Find the value of K and the closed loop poles at which the damping factor is 0.6.

5 (a) What are the advantages of frequency response analysis?

(b) Draw the Magnitude Bode plot for the system having the following transfer function:

G(s) = 5(1+2s)/[(1+4s)(1+0.25s)]

6 Check the stability of the system by Nyquist criterion: $G(s) = 100/s(s+1)(s^2+2s+2)$.

7 Design a PID controller to satisfy the following specifications. For a unity feedback system with open loop transfer function G(s) = 10/(s+1)(s+20).

(i) $K_v \geq 4$.

(ii) Damping ratio = 0.7.

(iii) Natural frequency of oscillations = 2 rad/sec.

8 (a) State the properties of state transition matrix.

(b) Compute the state transition matrix for the following system.

$$\begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix} \begin{bmatrix} x_1(t) \\ x_2(t) \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} r(t)$$

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Code: 9A02503

R09

B.Tech III Year I Semester (R09) Supplementary Examinations June 2017

CONTROL SYSTEMS

(Common to EEE, ECE, E.con.E, EIE & MCT)

Time: 3 hours Max. Marks: 70

Answer any FIVE questions

All questions carry equal marks

(Polar graph may be issued)

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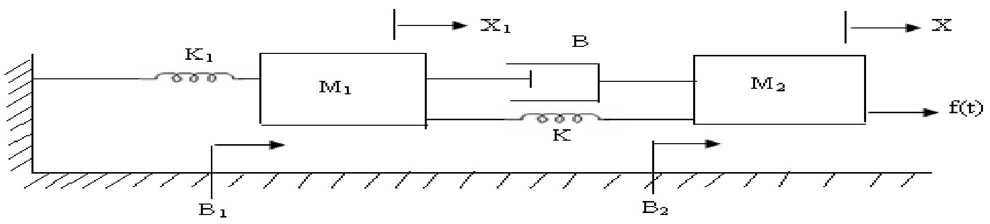
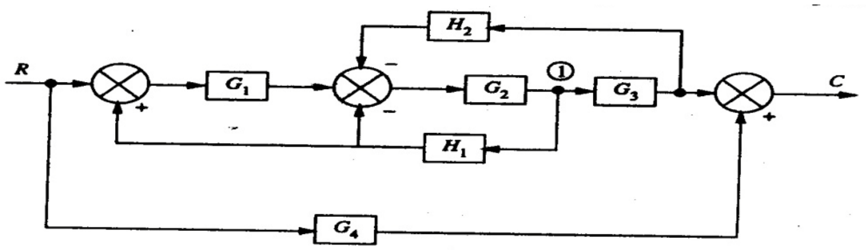
1 (a) Explain the basic components of control systems.

(b) Write the differential equations governing the mechanical system shown in the figure and determine the transfer function.



2 Find the transfer function shown in figure using block diagram algebra. [14M]



3 (a) Derive the transfer function for second order system subjected to a unit impulse input and draw the characteristics.

(b) Consider a unity feedback system with a closed loop transfer function $\frac{C(s)}{R(s)} = \frac{K_s+b}{s^2+as+b}$. Determine the open loop transfer function.

4 Sketch the root locus for the unity feedback system whose open loop transfer function is:

$G(s)=K/s(s^2+6s+10)$

5 (a) Find resonant peak and resonant frequency for the given damping ratio = 0.5. If the damping ratio is changed to 0.9, find the resonant peak and resonant frequency.

(b) Sketch the Bode Magnitude plot for the transfer function given by G(s)H(s)=2/[s(s+1)(1+0.2s)].

6 Determine the stability of the system using Nyquist stability criterion:

G(s)H(s) = 10/[s(s+1)(s+4)]

7 Consider a unity feedback system with open loop transfer function, G(s)=20/s(s+2)(S+4). Design a PD controller so that the damping ratio of 0.8 and natural frequency of oscillations as 2 rad/sec.

8 (a) State the properties of STM.

(b) Diagonalize the following system matrix $A = \begin{bmatrix} 0 & 6 & -5 \\ 1 & 0 & 2 \\ 3 & 2 & 4 \end{bmatrix}$.

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Code: 9A02503

R09

B.Tech III Year I Semester (R09) Regular & Supplementary Examinations December 2014

CONTROL SYSTEMS

(Common to EEE, E.Con.E, EIE, ECE and MCT)

Time: 3 hours Max Marks: 70

Answer any FIVE questions

All questions carry equal marks

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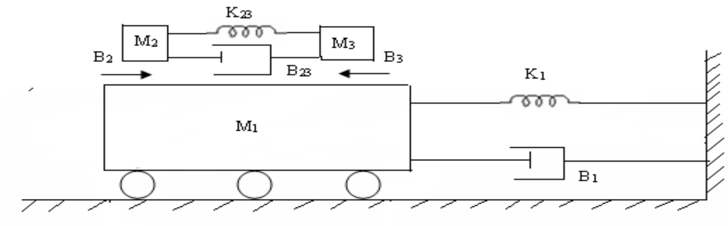
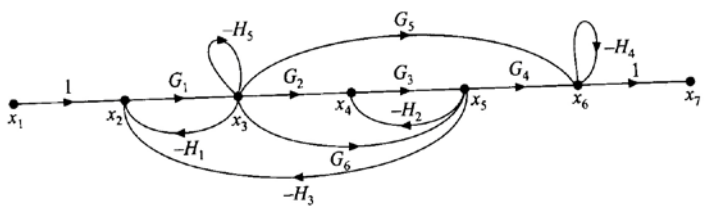
1 Write the differential equations governing the mechanical system shown in figure. Draw the force-voltage and force-current electrical analogous circuits and verify by writing mesh and node equations.



2 Find the transfer function of the system shown in figure using mason gain formula.



3 (a) Derive the expression for rise time, peak time, overshoot and settling time of second order system subjected to a unit step input.

(b) For the servomechanism with open loop transfer function given below, what type of input signal gives rise to a constant steady state error and calculate their values:

$G(s) = 10/(s + 2)(s + 3)$.

4 (a) What are the necessary and sufficient conditions to investigate the stability of the system using Routh- Hurwitz criterion?

(b) Factorize the given polynomial using Routh– Hurwitz criterion:

$F(s) = s^6 + 2s^5 + 8s^{4+} 12s^3 + 20s^2 + 16s + 16 = 0$.

5 Sketch the Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency to be 5 rad/sec.

$G(s) = Ks^2/[(1+0.2s)(1+0.02s)]$

6 Sketch the polar plot for following transfer function and from the plot determine the phase margin and gain margin: $G(s) = [(1 + 0.2s)(1 + 0.025s)]/[s^3(1 + 0.005s)(1 + 0.001s)]$.

7 (a) What is compensation? What are the different types of compensators?

(b) What is a lag compensator? Obtain the transfer function of lag compensator and draw pole-zero plot.

8 Diagonalize the system matrix. $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -2 & -5 & -4 \end{bmatrix}$

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Code: 13A02402 **R13**

B.Tech III Year I Semester (R13) Regular Examinations December 2015

CONTROL SYSTEMS ENGINEERING

(Common to ECE and EIE)

(Use of ordinary graph sheets, semi log graphs and polar graphs are permitted in the examination hall)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) What is the effect of positive feedback on stability?

(b) What are the differences between Synchro transmitter and control transformer?

(c) The closed loop transfer function of a second order system is $\frac{C(S)}{R(S)} = \frac{10}{S^2+6S+10}$. What is the type of damping in the system?

(d) Why derivative controller is not used alone in control systems?

(e) What is the necessary and sufficient condition for stability in Routh's stability criterion?

(f) What is meant by damping pole in Root locus diagram?

(g) Define Gain margin and Phase margin.

(h) In minimum phase system, how the start and end of polar plot are identified?

(i) State various properties of state transition matrix.

(j) What are the advantages of state space analysis over transfer function analysis?

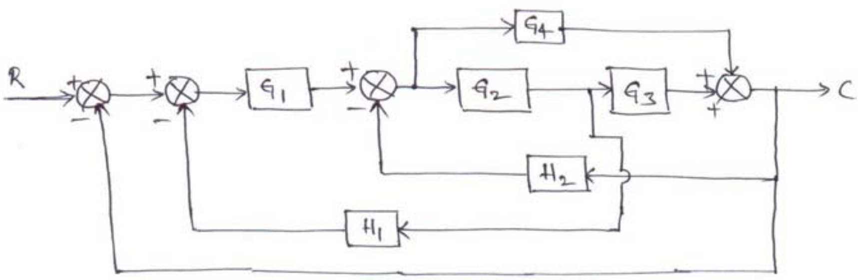
PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

2 (a) What is meant by open loop and closed loop control systems? Differentiate them.

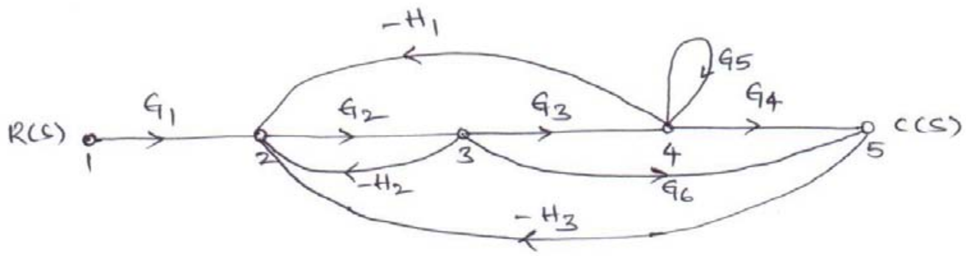
(b) Find the closed loop transfer function of the following block diagram using reduction technique.



OR

3 (a) Define transfer function and also derive transfer function for AC Servo motor.

(b) With the help of Mason's gain formula find the overall transfer function of the following signal flow graph.



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UNIT – II

4 (a) Obtain the response of a first order system $\frac{C(S)}{R(S)} = \frac{1}{1+Ts}$ for unit step input.

(b) A closed loop servo is represented by the differential equation: $\frac{d^2c}{dt^2} + 8\frac{dc}{dt} = 64e$. Where 'c' is the displacement of the output shaft, 'r' is the displacement of the input shaft and e = r – c. Determine un damped natural frequency, damping ratio and percentage maximum overshoot for unit step input.

OR

5 (a) What is meant by transient response and steady state response? Explain in detail about various time domain specifications.

(b) Find the various static error constants for a unity feedback control system whose open loop transfer function is: $G(s) = \frac{10(s+2)}{s^2(s+1)}$.

UNIT – III

6 With the help of Routh's stability criterion find the stability of the following systems represented by the characteristic equations:

(i) $s^4 + 8s^3 + 18s^2 + 16s + 5 = 0$.

(ii) $s^6 + 2s^5 + 8s^4 + 12s^3 + 20s^2 + 16s + 16 = 0$.

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

OR

7 A negative feedback control system has the forward path transfer function: $G(s) = \frac{K(s+1)}{s(s-1)(s^2+6s+25)}$. Draw the root locus for 0 ≤ K ≤ ∞.

UNIT – IV

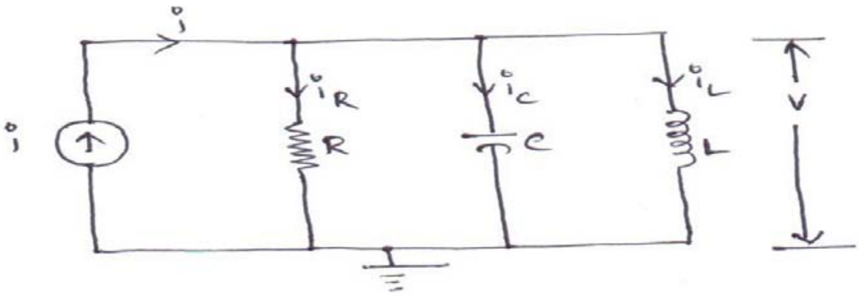
8 Sketch the bode plot for the following transfer function and determine phase margin and gain margin: $G(s) = \frac{75(1+0.2s)}{s(s^2+16s+100)}$.

OR

9 The open loop transfer function of a unity feedback system is given by: $G(s) = \frac{1}{s^2\,(1+s)\,(1+2s)}$. Sketch the polar plot and determine the gain margin and phase margin.

UNIT – V

10 (a) Write the state variable formulation of the following parallel RLC network. The current through the inductor and voltage across the capacitor are the output variables.



(b) Compute the resolvent matrix and state transition matrix of the state matrix: A=$\begin{bmatrix} 0 & 1 \\ -1 & -2 \end{bmatrix}$.

OR

11 (a) Obtain the state model of the transfer function: $\frac{Y(s)}{U(s)} = \frac{s^2+3s+4}{s^3+2s^2+3s+2}$

(b) Diagonalize the system matrix, $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$.

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Code: 13A02402 **R13**

B.Tech III Year I Semester (R13) Supplementary Examinations June 2016

CONTROL SYSTEMS ENGINEERING

(Common to ECE and EIE)

(Use of ordinary graph sheets, semi log graphs and polar graphs is permitted in the examination hall)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) Prove that the closed loop transfer function of a unity negative feedback control system having the forward path transfer function $G(s)$ is given by $\frac{G(s)}{1+G(s)}$.

(b) In an electrical circuit $i = C\frac{dV}{dt}$ where i is current, C is Capacitance and V is Voltage. Write the analogous equations for: (i) Mechanical (translational) system. (ii) Mechanical (rotational) system. Use force-current analogy.

(c) Define 'TYPE' and 'ORDER' of a system. What are the TYPE and ORDER of $G(s)H(s) = \frac{2}{s(1+s)}$?

(d) What is the effect of adding integral action to a proportional controller on: (i) Steady state error? (ii) Relative stability?

(e) What is the location of breakaway point in the root locus for the open loop transfer function: $G(s)H(s) = \frac{K}{(s+2)(s+4)}$.

(f) When is a system said to be Bounded Input-Bounded Output (BIBO) stable? What is the condition on impulse response for BIBO stability?

(g) A unity feedback system has $G(s) = \frac{100}{s(s+10)}$. What is the resonant frequency of the system?

(h) What is the importance of cut-off frequency and cut-off rate in control systems?

(i) Define 'State' and 'State variables'.

(j) What is the characteristic equation of a system having the State Matrix?

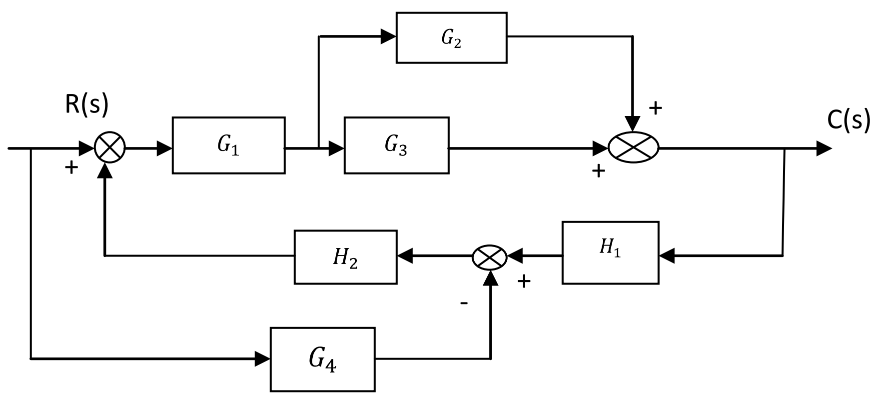
$$\mathbf{A} = \begin{bmatrix} 0 & 2 & 0 \\ 4 & 0 & 1 \\ -48 & -34 & -9 \end{bmatrix}$$

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

2 Find the overall transfer function, from R(s) to C(s), of the system shown below.



OR

3 With the help of necessary diagrams, describe the constructional and operational features of A.C Servo Motors. Derive the transfer function between the rotor position and error signal of an A.C Servo motor.

Contd. in page 2

UNIT – II

4 (a) A system has the closed loop transfer function $\frac{\omega_n^2}{s^2+2\zeta\,\omega_n s+\omega_n^2}$. It is required that the unit step response of the system should have a settling time of 2 sec according to 2% criterion; and the overshoot should be approximately 5%. What should be the closed loop pole locations?

(b) A unity feedback control system has the closed loop transfer function $\frac{ks+b}{s^2+as+b}$. Determine the steady state error in the unit ramp response, in terms of $k, a,$ and b.

OR

5 Derive the expressions for: (i) Rise time. (ii) Peak time. (iii) Maximum overshoot. (iv) Settling time of the unit-step response of an under damped prototype second order system. Hence determine the quantities for a system having the closed loop transfer function $\frac{16}{s^2+2s+16}$.

UNIT – III

6 (a) How many roots of the characteristic polynomial of a system $s^4 - s^2 - 2s + 2$ have positive real parts?

(b) Determine the value of K for which the characteristic polynomial of a system $s^4 + 8s^3 + 24s^2 + 32s + K$ has roots with zero real part.

OR

7 A unity feedback system has the open loop transfer function $G(s) = \frac{K}{s(s+2)(s^2+6s+25)}$.

(a) Sketch the root locus for $0 \le K \le \infty$.

(b) At what value of K does the system become unstable?

(c) What is frequency of sustained oscillations of the system when it just loses stability?

UNIT – IV

8 (a) Draw the Bode plot and determine the Gain Margin and Phase Margin for $G(s)H(s) = \frac{e^{-0.3s}}{s(1+s)}$.

(b) A Unity feedback control system has the Open Loop Transfer Function $G(s) = \frac{as+1}{s^2}$. What should be the value of a for the system to have Phase Margin of 45^0.

OR

9 (a) Draw a network of lag-lead compensator consisting of resistors and capacitors and derive its transfer function.

(b) Draw the Nyquist plot for the open loop transfer function $G(s)H(s) = \frac{(s+2)}{(s+1)(s-1)}$. Applying Nyquist stability criterion, determine whether the closed loop system is stable or not.

UNIT – V

10 Obtain the state model for the system represented by:

$$\frac{d^3y}{dt^3} + 6\frac{d^2y}{dt^2} + 11\frac{dy}{dt} + 10\,y = 3\,u(t).$$

OR

11 The state space representation of a system has the characteristic matrix $\boldsymbol{A} = \begin{bmatrix} 0 & 1 \\ -2 & 0 \end{bmatrix}$ and output matrix $\boldsymbol{C} = [1 \quad -1]$. Find the zero excitation response of the system for $\boldsymbol{X(0)} = [1 \quad 1]^T$.

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Code: 13A02402

R13

B.Tech III Year I Semester (R13) Supplementary Examinations June 2017

CONTROL SYSTEMS ENGINEERING

(Common to ECE and EIE)

Time: 3 hours | Max. Marks: 70

PART – A

(Compulsory Question)

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1 Answer the following: (10 X 02 = 20 Marks)

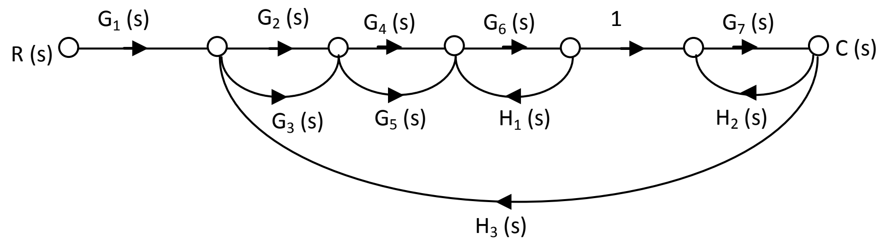
(a) If a forward path touched all closed loops, what would be the value of Δ_k?
(b) Write the analogous electrical elements in force voltage analogy for the elements of mechanical translational system.
(c) Define impulse signal with its waveform.
(d) How the system was classified depending on the value of the damping?
(e) Why marginally stable systems are considered unstable under the BIBO definition of stability?
(f) What kind of compensation improves the steady-state error?
(g) Write a short note on the correlation between the time and frequency response.
(h) How closed loop frequency response is determined from open loop frequency response using M and N circles?
(i) How can the poles of a system be found from the state equations?
(j) Write the general form of the state-transition matrix. How many constants would have to be found?

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

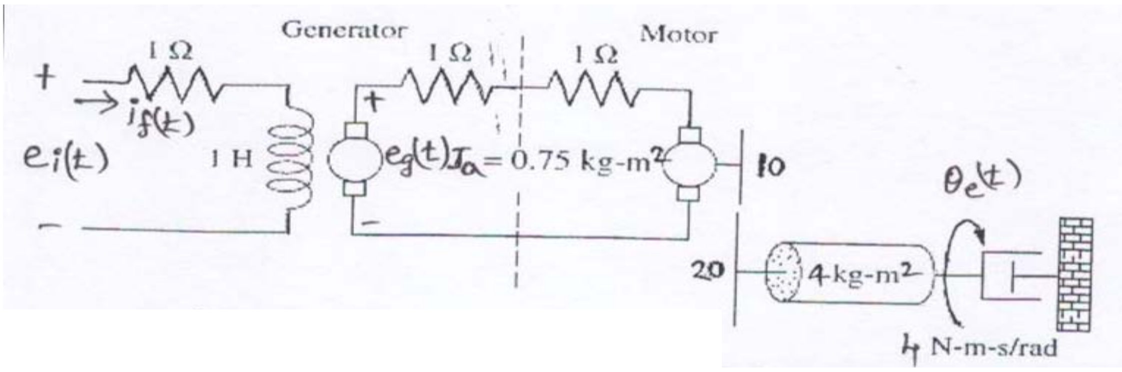
UNIT – I

2 Using Mason's rule, find the transfer function, $(s) = \frac{C(s)}{R(s)}$, for the system represented by figure below.



OR

3 A motor and generator are set up to drive a load as shown in figure below. If the generator output voltage is $e_g = K_f i_f(t)$, where $i_f(t)$ is the generator's field current, find the transfer function $G(s) = \frac{\theta_o(s)}{E_i(s)}$. For the generator, $K_f = 2\ \Omega$. For the motor, $K_t = 1\ N-m/A$, and $K_b = 1\ V-s/rad$.



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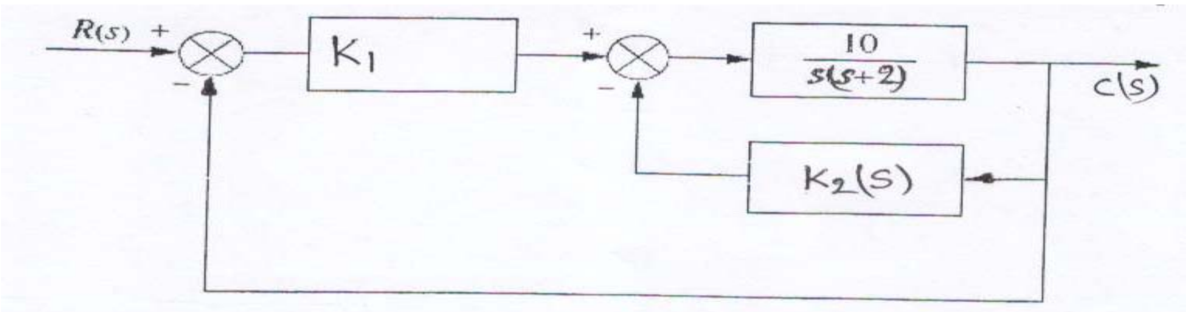
UNIT – II

4 For the system of figure below, find the values of K_1 and K_2 to yield a peak time of 1.5 second and a settling time of 3.2 seconds for the closed-loop system's step response.



OR

5 (a) What pole locations characterize: (i) The under damped system. (ii) The over damped system. (iii) The critically damped system.

(b) A system has a damping ratio of 0.5, a natural frequency of 100 rad/s and a DC gain of 1. Find the response of the system to a unit step input.

UNIT – III

6 Consider the unity feedback system shown with transfer function $(s) = \frac{K}{s(s+4)(s+6)}$. Draw the root locus and identify the stability.

OR

7 Using the Routh-Hurwitz criterion and the unity feedback system with $G(s) = \frac{K}{s(s+1)(s+2)(s+5)}$. (i) Find the range of K for stability. (ii) Find the value of K for marginal stability. (iii) Find the actual location of the closed-loop poles when the system is marginally stable.

UNIT – IV

8 Make a polar plot of the frequency response for the transfer function given by: $G(s) = \frac{(s+5)}{s(s+2)(s+4)}$

OR

9 Given a unity feedback system with the forward-path transfer function $G(s) = \frac{K}{s(s+1)(s+3)(s+6)}$ and a delay of 0.5 second, find the range of gain, K, to yield stability. Use Bode plots.

UNIT – V

10 Give the following state-space representation of a system, find Y(s):

$$\dot{X} = \begin{bmatrix} 0 & 1 & 0 \\ -2 & -4 & 1 \\ 0 & 0 & -6 \end{bmatrix} X + \begin{bmatrix} 0 \\ 0 \\ 1 \end{bmatrix} e^{-1}$$

$$Y = [0 \quad 0 \quad 1]X; \;\; X(0) = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

OR

11 Solve for y(t) for the following system represented in state space, where u(t) is the unit step. Use the Laplace transform approach to solve the state equation.

$$\dot{X} = \begin{bmatrix} -3 & 1 & 0 \\ 0 & -6 & 1 \\ 0 & 0 & -5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \\ 1 \end{bmatrix} u(t)$$

$$Y = [0 \quad 1 \quad 1]X; \;\; X(0) = \begin{bmatrix} 0 \\ 0 \\ 0 \end{bmatrix}$$

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Code: 13A02402

R13

B.Tech III Year I Semester (R13) Regular & Supplementary Examinations November/December 2016

CONTROL SYSTEMS ENGINEERING

(Common to ECE and EIE)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) Why is negative feedback preferred as compared to positive feedback in a closed loop system?

(b) Write any three basic properties of signal flow graph.

(c) Mention any two advantages of generalized error coefficients.

(d) A unity feedback system has a open loop transfer function of $(s) = \frac{10}{(s+1)(s+2)}$. Determine steady state error for unit step input.

(e) State the rule for finding the value of gain K at any point s_0 on the root locus diagram.

(f) In Routh array what conclusion you can make when there is a row of all zeros?

(g) Mention any two advantages and any two disadvantages of frequency response analysis.

(h) Which characteristic feature of the lag network is utilized for compensation?

(i) Give the expression to obtain the transfer function of a system from the given state model:

$$\dot{X} = AX + BU$$
$$Y = CX + DU$$

(j) Is the state-model of a system unique?

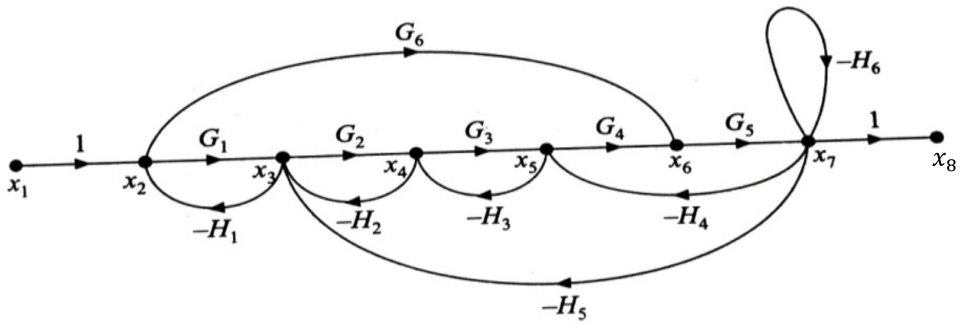
PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

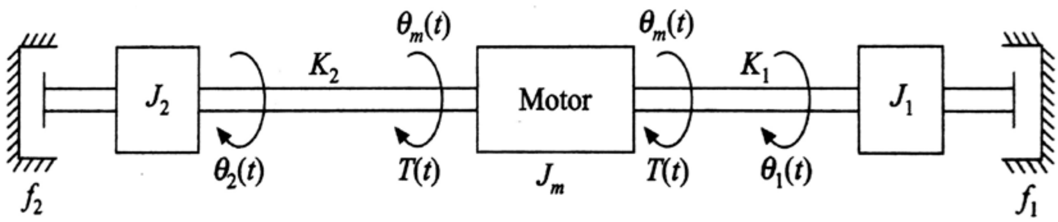
2 (a) Compare the merits and demerits of open loop and closed loop systems with examples

(b) Obtain the transfer function for the signal flow graph given in figure below, using Mason's gain formula.



OR

3 Write the torque equations of the rotational system shown in figure below. Draw the analogous electrical networks based on: (i) Torque-current. (ii) Torque-voltage analogies.



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UNIT – II

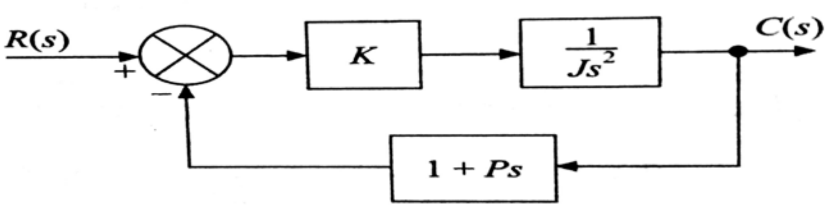
4 (a) Define the following time domain specifications: (i) Rise time. (ii) Delay time. (iii) Peak time. (iv) Peak over shoot. (v) Settling time.

(b) A Unity feedback control system is characterized by the following open-loop transfer function G(s) = (0.4 s+1) / s(s+0.6). Determine its transient response for a unit-step input. Evaluate the maximum overshoot and the corresponding peak time.

OR

5 (a) Write the merits and demerits of: (i) Proportional only controller. (ii) Integral controller.

(b) Determine the values of K and P of the closed-loop system shown in figure below, 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.



UNIT – III

6 (a) What are the difficulties in the formulation of the Routh table? Explain how they can be overcome.

(b) The characteristic polynomial of a system is:

$s^7 + 9s^6 + 24s^5 + 24s^4 + 24s^3 + 23s^2 + 15s = 0$. Determine the location of roots on s-plane and hence the stability of the system.

OR

7 Draw the complete root locus for $G(s)H(s) = \frac{K}{s(s+2)(s+4)}$. From the root locus plot, find the range of values of K for which the system will have damped oscillatory response. Also determine the value of K for a damping ratio of 0.5. With this value of K, find the closed-loop transfer function.

UNIT – IV

8 Sketch the Bode plot for the following transfer function and determine the system gain K for the gain cross over frequency to be 5 rad/sec.

$$G(s) = \frac{Ks^2}{(1+0.2s)\,(1+0.02s)}$$

OR

9 (a) Sketch the Nyquist plot and comment on the stability of the closed loop system whose open loop transfer function is $G(s)H(s) = \frac{K(s-4)}{(s+1)^2}$.

(b) Write the procedure for design of lead compensator using Bode plot.

UNIT – V

10 (a) Distinguish between transfer function approach and state variable approach.

(b) Obtain the state model for the transfer function of a control system given by: $\frac{Y(s)}{U(s)} = \frac{s^2+3s+4}{s^3+2s^2+3s+2}$.

OR

11 (a) Write the properties of state transition matrix.

(b) Diagonalize the system matrix given below:

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}$$

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Code: 15A02303

R15

B.Tech II Year II Semester (R15) Supplementary Examinations December 2017

CONTROL SYSTEMS ENGINEERING

(Common to ECE and EIE)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

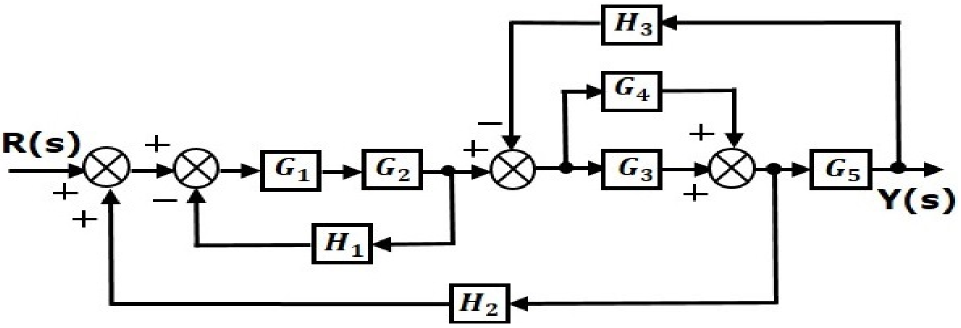
- (a) Compare open loop control system and closed loop control system.
- (b) What is servomechanism?
- (c) What is steady state error?
- (d) Mention two advantages of generalized error constants over static error constants.
- (e) How the roots of characteristic equation are related to stability?
- (f) What is centroid? How the centroid is calculated?
- (g) For a second order system, the damping ratio is 0.5 and natural frequency of oscillation is 8 rad/sec. Calculate resonant peak and resonant frequency.
- (h) What are the advantages of Bode plot?
- (i) What is companion or bush form of state model?
- (j) What are phase variables?

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

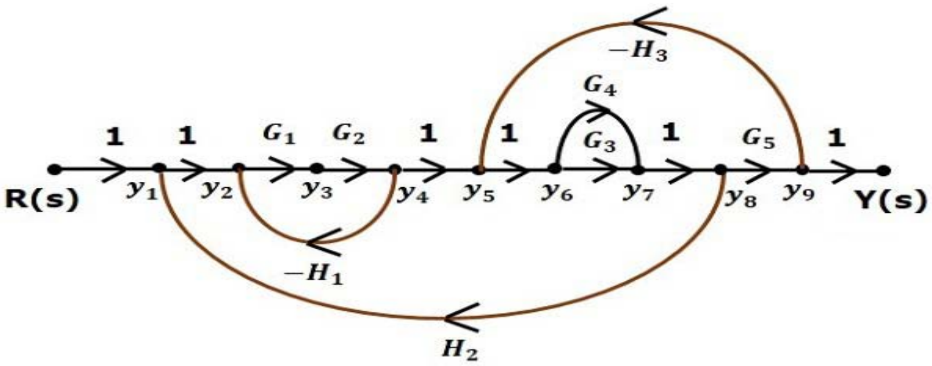
2 (a) Obtain the transfer function of below block diagram.



(b) Write the force balance and torque balance equations for basic elements in mechanical systems.

OR

3 (a) Obtain the transfer function of below signal flow graph using Mason's Gain formula.



(b) Obtain the transfer function of a armature controlled DC Servo motor.

Contd. in page 2

UNIT – II

4 (a) Derive an expression for the underdamped response of a second order feedback control system for step input.

(b) For a unity feedback control system, the open loop transfer function is: is $G(s) = \frac{10(s+2)}{s^2(s+1)}$. Find position, velocity and acceleration error constants.

OR

5 (a) For a unity feedback control system, the open loop transfer function is: $G(s) = \frac{10(s+2)}{s^2(s+1)}$. Find steady state error when the input $R(s) = \frac{3}{s} - \frac{2}{s^2} + \frac{1}{3s^2}$.

(b) Obtain expressions for rise time and peak time for a second order feedback control system for step input.(under damped case)

UNIT – III

6 (a) The open loop transfer function of a unity feedback control system is given by: G(s) = $\frac{K}{(s+2)(s+4)(s^2+6s+25)}$ by applying Routh criterion, discuss the stability of the closed loop system as a function of K. Determine the values of K which will cause sustained oscillations in the closed loop system. What are the corresponding oscillation frequencies?

(b) Define the following terms with respect to Root locus technique:
(i) Centroid. (ii) Asymptote. (iii) Break away point.

OR

7 (a) The open loop transfer function of a unity feedback control system is given by: G(s) = $\frac{K(s+9)}{s(s^2+4s+11)}$. Sketch the root locus of the system.

(b) Using Routh criterion, determine the stability of the system represented by the characteristic equation $s^2 + 8s^3 + 18s^2 + 16s + 5 = 0$. Comment on the location of the roots of characteristic equation.

UNIT – IV

8 (a) The open loop transfer function of a system is $G(s)H(s) = \frac{(1+4s)}{s^2(1+s)(2s+1)}$. Sketch the Nyquist plot and determine the stability of closed loop system. If the closed loop system is not stable then find the number of closed loop poles lying on the right half of s plane.

(b) Sketch the polar plot of:
(i) $G(s) = \frac{1}{s^2(1+sT_1)(1+sT_2)(1+sT_3)}$. (ii) $G(s) = \frac{1}{(1+sT_1)(1+sT_2)(1+sT_3)}$. (iii) $G(s) = \frac{1+sT}{sT}$

OR

9 The open loop transfer function of a unity feedback control system is given by $G(s) = \frac{Ke^{-0.2s}}{s(s+2)(s+8)}$. Draw the Bode plot and find K so that the system is stable with, (i) Gain margin is equal to 2db. (ii) Phase margin is equal to 45^0.

UNIT – V

10 (a) Determine the canonical state model of the system whose transfer function is: $T(s) = \frac{2(s+5)}{(2+s)(3+s)(4+s)}$ and draw block diagram representation of the state model.

(b) Write the properties of state transition matrix.

OR

11 (a) Determine the state model of the system whose transfer function is: $T(s) = \frac{10}{s^2+4s^2+2s+1}$ and draw block diagram representation of the state model.

(b) Define controllability and observability and state the condition for controllability and observability.

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Code: 15A02303

R15

B.Tech II Year II Semester (R15) Regular & Supplementary Examinations May/June 2018

CONTROL SYSTEMS ENGINEERING

(Common to ECE and EIE)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) Distinguish between open loop and closed loop systems.

(b) State Mason's gain formula.

(c) List the time domain specifications.

(d) Determine the static error constants for a system given by: G(s)H(s) = $\frac{10(s+2)(s+3)}{s(s+1)(s+4)(s+5)}$.

(e) State limitations for Routh's stability.

(f) How do you determine the centroid and angle of asymptotes?

(g) Find the resonant frequency and resonant peak for a unity feedback system with: $G(s) = \frac{100}{s(s+10)}$.

(h) What is Polar plot?

(i) What are the advantages of state space analysis?

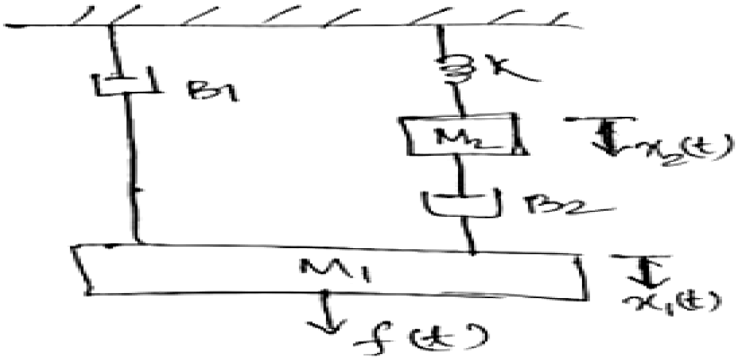
(j) State the properties of state transition matrix.

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

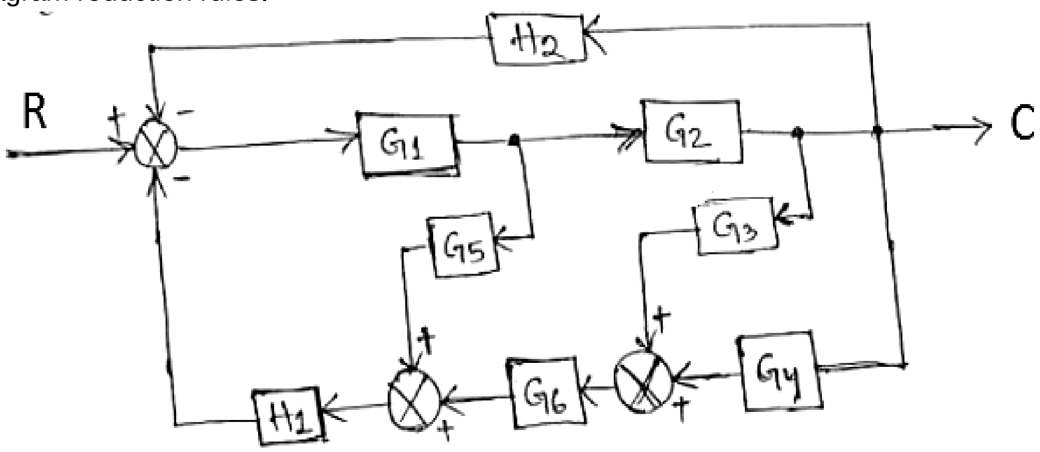
2 (a) Write differential equations for the mechanical system shown in figure below.



(b) Explain with a neat sketch, the working of Synchro transmitter and Receiver.

OR

3 Determine the overall transfer function C/R for the block diagram shown in figure below by using block diagram reduction rules.



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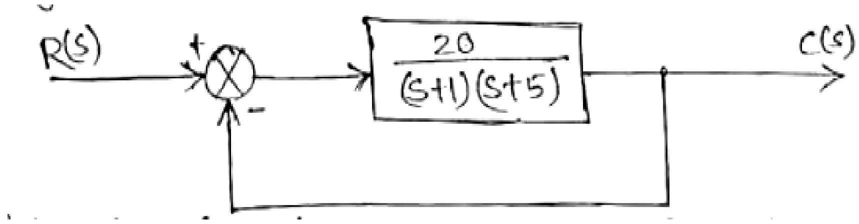
UNIT – II

4 Derive the expression for transient response of a under damped second order system with unit step input and draw the response curve.

OR

5 The block diagram of a unity feedback system is shown in figure below.



Determine the characteristic equation of the system: (i) Natural frequency. (ii) Damping factor. (iii) Damping frequency. (iv) Rise time. (v) Peak time. (vi) Peak overshoot.

UNIT – III

6 Determine the value of 'a' and 'K' at which a unity feedback control system having an open loop transfer function $G(s) = \frac{K(s+1)}{S^3+aS^2+2S+1}$, will have sustained oscillations at ω = 2 rad/sec.

OR

7 Sketch the root locus plot for a system described by: G(s)H(s) = $\frac{K}{s(s+3)(s+6)}$. Comment on its stability. Determine the value of K for (i) critical damping (ii) Marginal stability (iii) for damping factor 0.6.

UNIT – IV

8 The open loop transfer function of a system is given by: G(s) = $\frac{20}{s(s+1)(1+0.01s)}$. Sketch the Bode plot and determine the gain Margin and Phase Margin.

OR

9 The open loop transfer function of a system is given by: G(s) = $\frac{40}{(s+4)(s^2+2s+1)}$. Sketch the Nyquist plot and comment on the stability of the system.

UNIT – V

10 Determine the state vector x(t) for the state model $\begin{bmatrix}\dot{x}_1\\\dot{x}_2\end{bmatrix} = \begin{bmatrix}-12 & 2/3\\-36 & -1\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix} + \begin{bmatrix}1/3\\1\end{bmatrix}u$; and the initial conditions are $x_1(0) = 2$, $x_2(0) = 1$.

OR

11 State whether the system is controllable and observable for the linear time invariant system characterized by the state model: $\begin{bmatrix}\dot{x}_1\\\dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\2 & -3\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix} + \begin{bmatrix}0\\1\end{bmatrix}u, Y(t) = \begin{bmatrix}1 & 1\end{bmatrix}\begin{bmatrix}x_1\\x_2\end{bmatrix}$.

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Code: 15A02303 **R15**

B.Tech II Year I Semester (R15) Regular & Supplementary Examinations November/December 2018

CONTROL SYSTEMS ENGINEERING

(Electrical & Electronics Engineering)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) What is the effect of positive feedback on stability of the system?

(b) What is the basic rule used for block diagram reduction technique?

(c) What are test signals and write their significance?

(d) Define IAE, ITAE.

(e) Determine the stability of the system whose characteristic equation is given by: $S^4 + 6S^3 + 23S^2 + 40S + 50 = 0$ using Routh's stability criterion.

(f) Draw the Root-Locus plot of $G(S)\,H(S) = \frac{K}{S+P}$.

(g) Define gain margin and phase margin.

(h) Define state and state variable.

(i) What are the advantages of state space modeling using physical variables?

(j) What is similarity transformation?

PART – B

(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

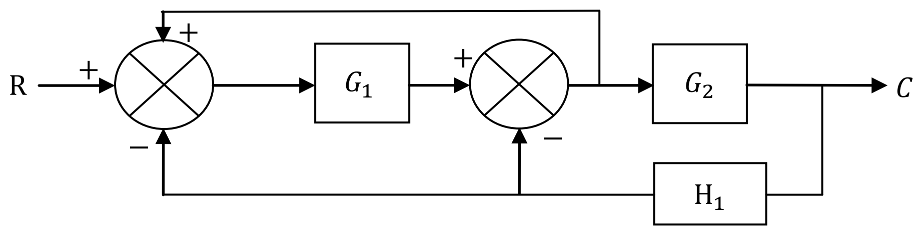
2 (a) Explain the operation of synchro transmitter and receiver.

(b) Write the block diagram reduction techniques in the analysis of control systems.

OR

3 (a) Write the analogy between mechanical systems and electrical systems.

(b) Determine C/R of the system shown in figure below by block diagram reduction technique.



UNIT – II

4 (a) For a unity feed-back system whose open-loop transfer function is $G(S) = \frac{100}{(1+0.2S)(1+2S)}$. Find the position, velocity and acceleration error constants.

(b) What will be the nature of response of a second order system with different types of damping?

OR

5 (a) Derive the expression for 2nd order system under damped system with unit step as input.

(b) The open loop, transfer function of a unity feedback system is $G(S) = \frac{1}{1+S}$. Using generalized error series determine the steady state error when the system is excited by $R(t) = 1 + t + t^2$.

Contd. in page 2

UNIT – III

6 (a) The open loop transfer function of a unity feedback system is given by $G(S) = \frac{K}{S(S+3)(S^2+S+1)}$. Determine the values of 'K' that will cause sustained oscillations in the closed loop system. Also find the oscillation frequency.

(b) What is centroid and how it is calculated?

OR

7 Sketch the root locus for the open loop transfer function of unity feedback control system given by $G(S)\,H(S) = \frac{K}{S(S+1)(S+2)}$. Also find K of breakaway point.

UNIT – IV

8 (a) Sketch polar plot of $G(S) = \frac{1}{(1+ST_1)(1+ST_2)}$.

(b) The open-loop transfer function of closed loop system is $G(S)\,H(S) = \frac{1+4S}{S^2(S+1)(2S+1)}$. Determine the stability using Nyquist criterion.

OR

9 Sketch the bode plot for the transfer function $G(S) = \frac{K\,S^2}{(1+0.2S)(1+0.2S)}$. Determine the system gain 'K' for the gain cross-over frequency to be 5 rad/sec.

UNIT – V

10 (a) Explain various methods of evaluation of state transition matrix.

(b) Given $\dot{x}(t) = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} x(t) = A.x(t)$. Find Eigen values, vectors and response when X(0) = $\begin{bmatrix} 1 \\ 1 \end{bmatrix}$.

OR

11 (a) Discuss the merits and demerits of representing a state model into: (i) Phase variable form. (ii) Canonical form.

(b) Find the state transition matrix for $\dot{X} = \begin{bmatrix} -2 & 1 & 0 \\ 0 & -2 & 1 \\ 0 & 0 & -2 \end{bmatrix} x$.

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Code: 15A02303

R15

B.Tech II Year II Semester (R15) Regular Examinations May/June 2017

CONTROL SYSTEMS ENGINEERING

(Common to ECE and EIE)

Time: 3 hours Max. Marks: 70

PART – A

(Compulsory Question)

Use of polar chart, Bode graph sheet and Nyquist chart is allowed in examination hall.

*****

1 Answer the following: (10 X 02 = 20 Marks)

(a) List the advantages of negative feedback in control system.
(b) Write the Mason's gain formula of signal flow graph.
(c) How do you find the type of a control system?
(d) Find the value of position error constant for second order system using ramp input.
(e) Write the necessary and sufficient condition for stability in Routh's stability criterion.
(f) Define BIBO stability.
(g) Write the expression for resonant peak in frequency response analysis.
(h) What is meant by lag compensation?
(i) Define state and state variable.
(j) What are the properties of state transition matrix?

PART – B

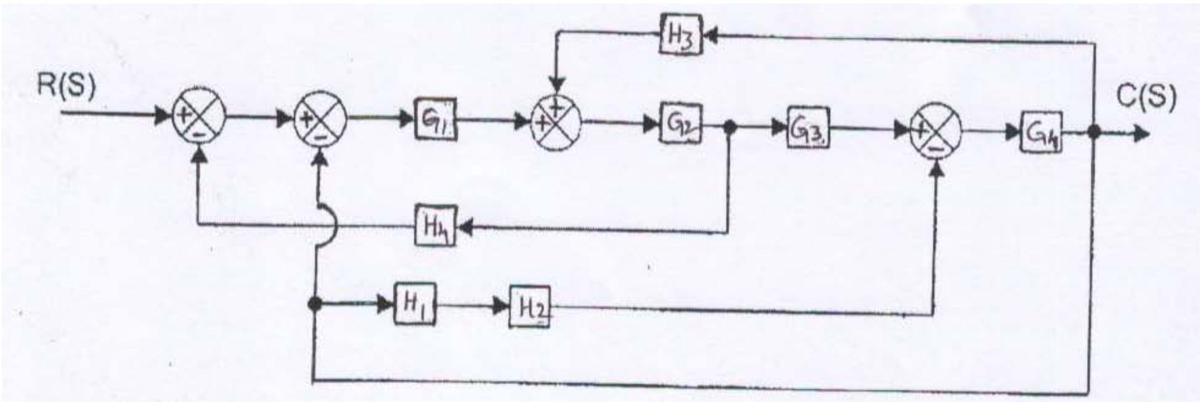
(Answer all five units, 5 X 10 = 50 Marks)

UNIT – I

2 Derive the transfer function of DC servomotor.

OR

3 Find the transfer function C(S) / R(S) for the system using block diagram reduction technique.



UNIT – II

4 (a) Transfer function of unity feedback control system is $G(s) = \frac{25}{s(s+5)}$. Obtain the rise time, peak time, maximum overshoot and the settling time when the system is subjected to a unity step input.

(b) Derive the time response of first order system for step input.

OR

5 The open loop transfer function of a system with unity feedback $G(S) = 10/S\,(0.1S + 1)$. Evaluate the static error constants of the system. Obtain the steady state error of the system, when subjected to an input given by the polynomial $r(t) = a_0 + a_1 t + a_2 t^2/2$.

Contd. in page 2

UNIT – III

6 Draw the root locus plot for the system whose open loop transfer function is given by:

$$G(S)H(S) = K / [S(S+4)(S2+4S+13)]$$

OR

7 Obtain the Routh array for the system whose characteristic polynomial equation is:

$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$. Check the stability.

UNIT – IV

8 Explain in detail about lag-lead compensator technique.

OR

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

$$G(S) = 1/[S(1+S)(1+2S)]$$

Sketch polar plot and determine the gain and phase margin.

UNIT – V

10 Consider a system with state model given below:

$$x = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -1 & -5 & -1 \end{bmatrix} X + \begin{bmatrix} 0 \\ 5 \\ -24 \end{bmatrix} u;\ y = \begin{bmatrix} 1 & 0 & 0 \end{bmatrix} x + [0]u$$

Verify, the system is observable and controllable.

OR

11 (a) Obtain the state model of the system described by the following transfer function:

$Y(s)/U(S) = 5 / [(S^2 + 6S + 7)]$.

(b) Explain about diagonalization.

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Code: R7311003

R07

B.Tech III Year I Semester (R07) Supplementary Examinations December 2014

CONTROL SYSTEMS

(Electronics and Instrumentation Engineering)

Time: 3 hours Max Marks: 80

Answer any FIVE questions

All questions carry equal marks

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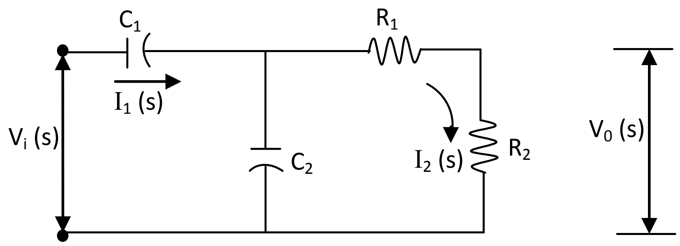
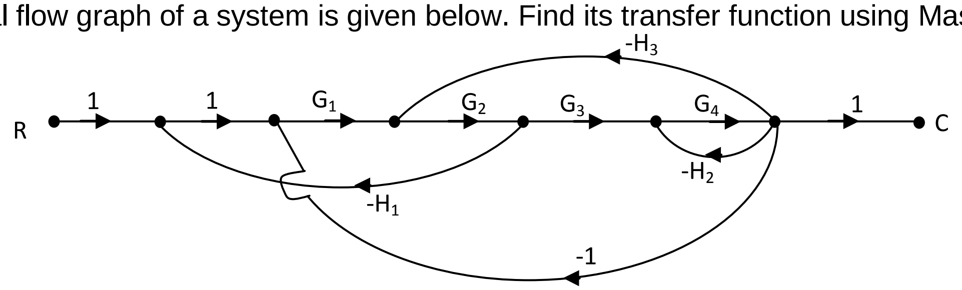
1 (a) For network shown below, derive the transfer function. Assume zero initial conditions.



(b) What is meant by stability of control system? Discuss the effect of feedback on sensitivity.

2 (a) Derive the transfer function and develop the block diagram of armature controlled DC servomotor.

(b) A signal flow graph of a system is given below. Find its transfer function using Mason's gain formula.



3 (a) Find the steady state error as a function of time for the unity feedback system $G(s) = \frac{100}{s(1+0.1s)}$ for the input, $r(t) = 1 + 2t + \frac{t^2}{2}$.

(b) Derive steady state errors for various inputs and type of systems.

4 (a) The characteristic equation of a control system is given as $s^4 + 20\,ks^3 + 5s^2 + (10+k)s + 15 = 0$. Determine the range of values of k for the system to be stable.

(b) Sketch the root locus of the system with loop transfer function: $G(s)\,H(s) = \frac{k}{s(S+2)(s^2+s+1)}$.

5 For a unity feedback system with the open loop transfer function $\frac{10s}{(0.1s+1)(0.01s+1)}$, draw the Bode plot and determine the frequency at which the plot crosses the 0 db line.

6 Draw the Nyquist plot for the system $G(s)\,H(s) = \frac{k}{s(1+2s)(1+5s)}$. Find the critical value of k for stability.

7 Discuss the design of lead-lag controllers.

8 (a) Define controllability and observability. What are the tests for determination of controllability and observability of a given system?

(b) Find the state transition matrix for the following system: $\dot{X} = \begin{bmatrix} 1 & 0 \\ -1 & -2 \end{bmatrix} X$.

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Code :R7311003 **R7**

III B.Tech I Semester(R07) Supplementary Examinations, May 2011

CONTROL SYSTEMS

(Electronics & Instrumentation Engineering)

Time: 3 hours Max Marks: 80

Answer any FIVE questions

All questions carry equal marks

⋆ ⋆ ⋆ ⋆ ⋆

1. (a) Distinguish between open loop and closed loop systems. Explain merits and demerits of open loop and closed loop systems.

   (b) For the given lever systems in Fig P1, determine the equation relating f and x.

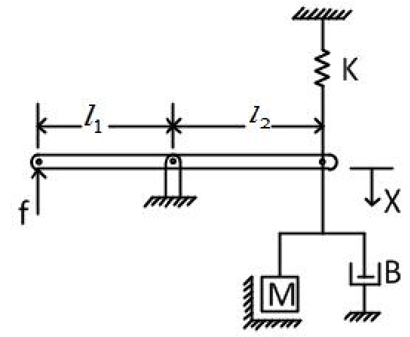

Fig.P1

2. (a) Find the transfer function of the system shown in Fig P2.

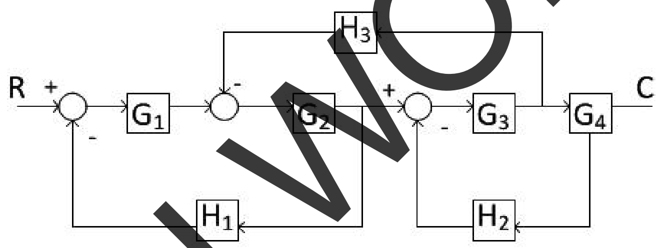

Fig P2

   (b) Find the transfer function of a field controlled d.c Servo Motor.

3. (a) Derive the time domain specification for a standard second ordered system.

   (b) A unit feedback system is characterized by an open-loop transfer function $G(s) = \frac{K}{s(s+10)}$. Determine the gain K so that the system will have a damping ratio of 0.6. For this value of K determine settling time, peak overshoot and times to peak overshoot for a unit-step input.

4. (a) The characteristic equation of a feedback control systems is $s^3 + (K + 0.5)s^2 + 4Ks + 50 = 0$. Using R-H criterion determine the value of K for which the systems is stable.

   (b) Determine (i) the number of root loci (ii) Number of asymptotes (iii) root loci on the real axis if any for the following: $GH(s) = \frac{K(s+1)}{s^3(s+2)(s+3)}$

5. Construct a Bode plot for the system whose open-loop transfer function is given by $G(s)H(s) = \frac{4}{s(1+0.5s)(1+0.08s)}$ and determine (a) the gain margin, (b) phase margin and, (c) the closed -loop stability.

6. (a) Explain the Nyquist criterion for assessing the stability of a closed loop system.

   (b) Sketch the Nyquist plot for the transfer function: $G(s)H(s) = \frac{52}{(s+2)(s^2+2s+5)}$ Discuss its stability.

7. (a) Explain the tuning sequences of PID controllers.

   (b) Explain the performance comparison between the Lead and Lag comparators.

8. Explain the properties of state transition matrix. A linear time invariant system is described by the state equation $\dot{X} = \begin{bmatrix} 0 & 6 \\ -1 & 5 \end{bmatrix} X + \begin{bmatrix} 0 \\ 1 \end{bmatrix} [u]$ and $y = [\ 1 \quad 0\ ] X$, $X(0) = \begin{bmatrix} 0 \\ 0 \end{bmatrix}$ obtain the state transition matrix, hence obtain the output response $y(t)$, $t \geq 0$ for a unit step input.

⋆ ⋆ ⋆ ⋆ ⋆