Code No: RT22026 **R13** SET - 1

II B. Tech II Semester Regular Examinations, April/May – 2016
CONTROL SYSTEMS
(Electrical and Electronics Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **THREE** Questions from **Part-B**

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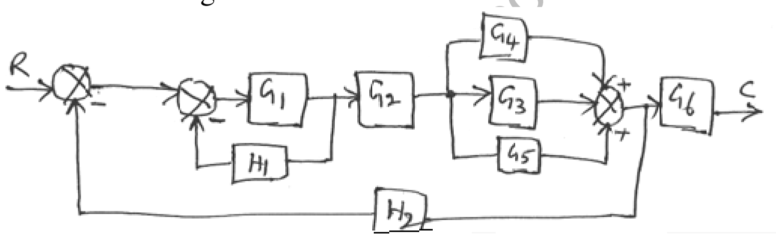
PART –A

1. a) State and explain the Mason's gain formula
   b) Define steady state error
   c) What is the necessary condition that the characteristic equation of a feedback system satisfies the BIBO stability?
   d) State the Nyquist Stability criterion
   e) Why bode plots are commonly used in the frequency domain design
   f) What are the properties of STM

PART -B

2. a) Explain the reduction of parameter variation by feedback.
   b) Using block diagram reduction technique finds the transfer function for the system shown in below Figure



3. a) What is meant by step, ramp, parabolic and impulse inputs
   b) The open-loop transfer function of a control system with unity feedback is

$$G(s) = \frac{150}{s(1+0.25s)}$$

   i) Evaluate the error series for the system
   ii) Determine the steady state error for an input

$$r(t) = (1+t^2)\,u(t)$$

4. a) Explain the construction rules for root locus technique
   b) Test the stability of the system with the following characteristic equation by Routh's test $s^6 + 2s^5 + 8s^4 + 20s^2 + 16s + 16 = 0$
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5. a) Explain frequency domain specifications.
   b) A unity feedback control system has an open loop transfer function given by G(s) H(s) = $\frac{100}{s(s+5)(s+2)}$ .Draw Nyquist diagram and determine stability.

6. For the given open loop transfer function, $G(s) = \frac{K}{s(s+4)(s+6)}$.

   Design suitable lead compensation so that phase margin is ≥ 40^o and velocity error constant, $K_v \geq 20$.

7. a) List out the advantages of state space techniques
   b) Determine the state model of the system for the following transfer function

$$\frac{Y_{(s)}}{U_{(s)}} = \frac{2s^2+s+5}{s^3+6s^2+11s+4}$$

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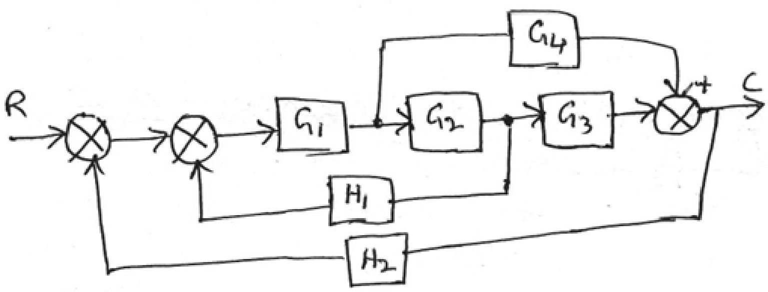
PART –A

1. a) How the control systems are classified
   b) Define steady state response
   c) When does the procedure for making the Routh array gets terminated
   d) What is meant by asymptotes
   e) What is the need of compensator
   f) What are the merits of state variable technique

PART –B

2. a) What are the requirements for good servomotor
   b) Find the gain of the system using signal flow graph approach for a given block diagram as shown in Figure below.



3. a) Explain time domain specification
   b) For a negative feedback control system
   $G(s) = \frac{10}{s(0.45+1)}$ and $H(s) = \frac{5}{s+4}$. Using generalized error series determine the steady state error of the system when the input applied is $r(t) = 1+3t+4t^2$.
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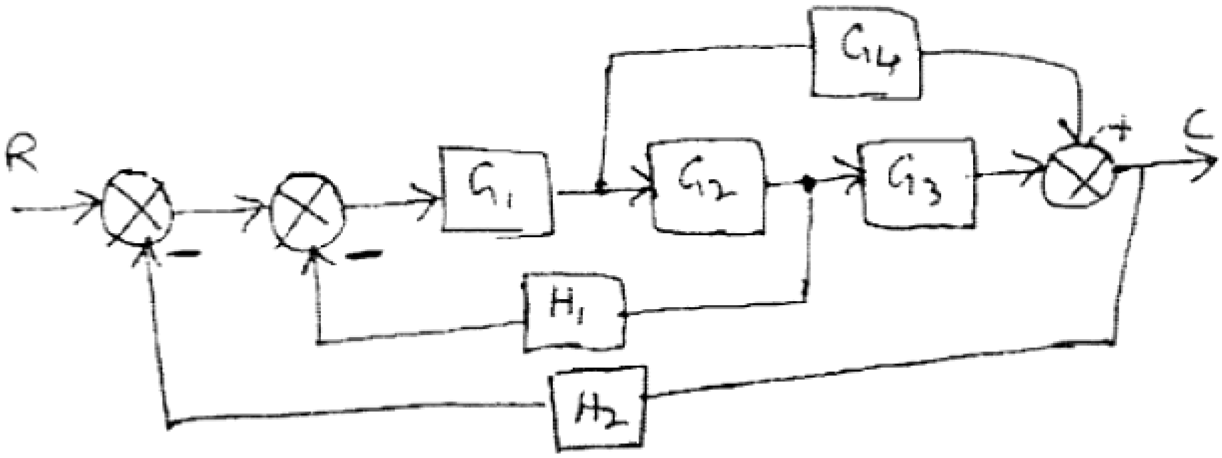

R
C
G_4
+
G_1
G_2
G_3
H_1
H_2
-
-

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4. a) Define and derive the breakaway point on the root locus
   b) Determine the number of roots of a given polynomial with real parts between zero and –1, $8s^2 + 44s^4 + 126s^3 + 219s^2 + 258s + 85 = 0$

5. a) Derive the relation between phase margin and damping ratio
   b) Sketch the polar plot for a given open loop transfer function.

$$G(s) = \frac{10}{s(s+1)(s+3)}$$

6. A unit feedback system has an open loop transfer function

$G(s) = \dfrac{K}{s(s+1)(0.2s+1)}$. Design a phase lag compensator to meet the following specifications.

Velocity error constant = 8

Phase margin $\geq 40^o$

7. a) Explain the concepts of state, state variables and state model
   b) Determine the state model of the system characterized by the differential equation $(s^4 + 2s^2 + 8s^3 + 4s + 3)\ Y(s) = 10\ U(s)$

Code No: RT22026 **R13** SET - 3

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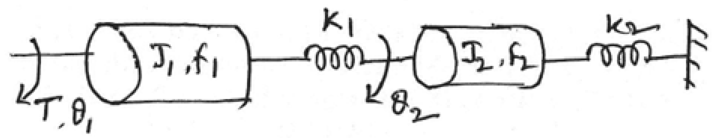
PART –A

1. a) Illustrate between open loop and closed loop control systems
   b) What are the standard test signals used in time domain analysis
   c) What is the effect of addition of poles on root locus
   d) What are the merits of frequency domain analysis
   e) What are the different types of electrical compensators
   f) Define the concept of state in state space analysis.

PART -B

2. a) Describe the AC servo motor and draw its torque vs speed characteristics
   b) Find the transfer function $\frac{\theta_2(s)}{T(s)}$ for a given rotational mechanical system is as shown in below figure



3. a) Define the steady state error and error constants of different types of inputs
   b) A unity feedback system has a forward path transfer function $G(s) = \frac{9}{s(s+1)}$. Find the value of damping ratio, undamped natural frequency of the system, percentage over shoot, peak time and settling time.

4. a) Explain the special cases in Rouths stability criterion
   b) Sketch the root locus for the characteristic equation is
      $s\,(s+1)\,(s+2) + k\,(s + 1.5) = 0$
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5. a) Derive the correlation between time domain and frequency domain specifications
   b) Sketch the Bode plot and determine the Gain margin and phase margin

   For the transfer function is given, G(s) == $\frac{10}{s(1+0.4s)(1+0.1s)}$

6. A unity feedback system has an open loop transfer function

   $G(s) = \frac{K}{s(s+3)(s+10)}$ design a suitable lag compensation so that phase margin is $\geq 45^0$ and velocity error constant, $K_v \geq 15$

7. a) State and explain the concepts of Controllability and Observability.
   b) Given $G(s) = \frac{2}{s^2+5s+6}$, obtain the state space model of the system in the diagonal canonical form.

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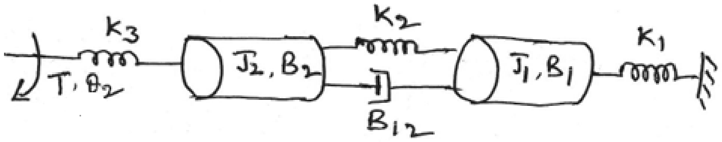
PART –A

1. a) Define the closed loop control system with diagram
   b) What is the different between type and order of a system
   c) What are the merits of root locus
   d) What are the frequency domain specification
   e) What is the need of lead-lag compensator
   f) What is controllability

PART –B

2. a) Explain the construction and operating principle of synchro transmitter with neat diagrams
   b) Derive the transfer function $\frac{\theta_2(s)}{T(s)}$ for the given rotational mechanical system shown in below figure



3. a) Derive the generalized error constants
   b) A unity feedback control system has a loop transfer function, G(s) = $\frac{10}{s(s+2)}$. Find the rise time, percentage overshoot, peak time and settling time for a step input of 12 units.

4. a) What are the necessary and sufficient conditions of stability for linear time invariant systems?
   b) The open loop transfer function of a unity feedback control system is given by G(s) = $\frac{k}{s(s+3)^2}$. Sketch the root locus plot of the closed loop system for positive values of k and there from determine the value of k that would make the system stable.
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5. a) Discuss the calculation of gain crossover frequency and phase crossover frequency with respective to the polar plots

b) Determine the resonant frequency ω_r, resonant peak M_P and bandwidth for the system whose transfer function is

$$G(j\omega)= \frac{5}{5+j2\omega+(j\omega)^2}$$

6. Consider the open loop transfer function with unit feedback system,

$$G(s)=\frac{k}{s(s+1)(0.5s+1)}.$$

Design the lead-lag compensator so that

a) Velocity error constant K_v is 5 sec^{-1}

b) Phase margin not greater than 40^o

c) Gain margin not greater than 10 db

7. a) State and prove the properties of STM

b) Reduce the matrix A to diagonal matrix, $A = \begin{bmatrix} 3 & -2 \\ -1 & 2 \end{bmatrix}$