Code No: R1622042 **R16** SET - 1

II B. Tech II Semester Regular Examinations, April - 2018
CONTROL SYSTEMS
(Com to ECE, EIE, ECC)

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 **FOUR** Questions from **Part-B**

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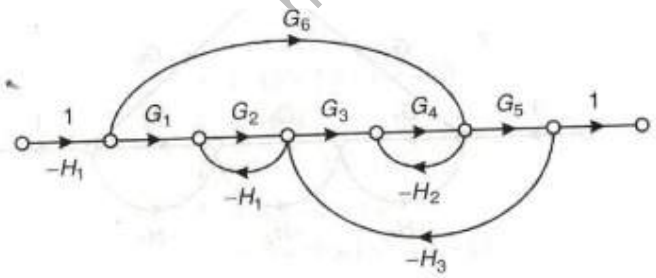
PART –A

1. a) List out the main limitations of open-loop system over the closed loop system? (2M)
   b) Define the characteristic equation of armature controlled dc motor? (2M)
   c) What are the breakaway points of the characteristic equation $1+\frac{K(s+1)}{s(s-1)}=0$? (2M)
   d) What is frequency domain specification (2M)
   e) What are the effects of adding lead-lag compensator to the given system? (2M)
   f) What do you mean by homogeneous state equations? (2M)

PART -B

2. a) Why is negative feedback invariably preferred in closed loop systems? (7M)
   b) Find the transfer function of the system shown in figure using Mason's gain formula? (7M)



3. a) Describe the various characteristics of Synchro transmitter and receiver? (7M)
   b) A closed loop servo is represented by the differential equation (7M)
   $\frac{d^2c}{dt^2}+8\frac{dc}{dt}=64e$, where c displacement of the output shaft, r is the displacement of the input shaft and $e=(r-c)$. Determine under-damped natural frequency, damping ratio and % M_p for unit step input?
4. A unity feedback system has open loop transfer function (14M)

$$G(s)=\frac{K}{s(s^2+4s+13)}$$

Sketch the root locus as a function of K, find the range of K for which system is stable, find the K for which purely imaginary roots if exists and their roots?
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5. Draw the Nyquist plot for the closed loop system, whose open-loop transfer function is given as (14M)

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

Determine the stability of open loop and closed loop systems?

6. Design a lead compensator for a unity feedback open loop transfer function $G(s) = \frac{1}{s(s+2)}$ having the damping coefficient 0.45, velocity error constant > 20 sec^{-1} and settling time is small. (14M)

7. a) What is meant by state transition matrix give its properties? (4M)

b) Consider the system is defined by (10M)

$$X = Ax + BU$$
$$Y = Cx$$

Where

$$A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ -6 & -11 & -6 \end{bmatrix}; B = \begin{bmatrix} 1 \\ 0 \\ 1 \end{bmatrix}; C = [10 \quad 5 \quad 1]$$

Check the controllability and observability of the system

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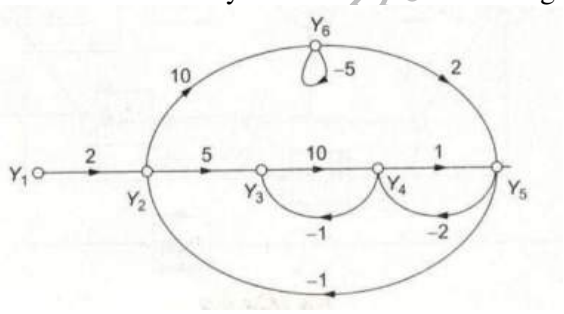
PART –A

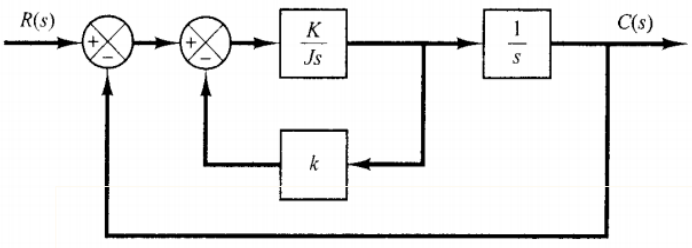
1. a) State whether the transfer function is applicable for non-linear system? (2M)
   b) The resolution of the potentiometer depends on which parameters? (2M)
   c) If a pole is added to the system, list out the effects take place in the root locus of the original system? (2M)
   d) Define gain margin and phase margin (2M)
   e) The transfer function of a compensating network is of the form, $G_c = \frac{1+\alpha T_s}{1+T_s}$ if this is a phase-lag or phase-lead network what is the value of α? (2M)
   f) What do you mean by non-homogeneous state equations? (2M)

PART -B

2. a) What are the basic elements used for modeling rotational mechanical system? Write its force balance equations? (7M)
   b) The SFG of the system is shown in the figure, obtain the transfer function (7M)



3. a) Explain the working of AC servo motor and derive its transfer function? (7M)
   b) Determine the values of K and k of the closed-loop system shown in figure so that the maximum overshoot in unit-step response is 20%and the peak time is 1.8 sec. Assume that J = 1kg-m^2. (7M)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4. The characteristic equation of the system is given by (14M)

$s^3 + 2s^2 + (K+1)s + 3K = 0$

Sketch the root locus as a function of K, find the range of K for which system is stable, and also find the K for which purely imaginary roots if exists and their roots

5. Draw the Nyquist plot and find the stability of the following open loop transfer function of unity control system (14M)

$$G(s) = \frac{K(s+1)}{s^2(s+10)}$$

If the system is conditionally stable find the range of K for which the system is stable?

6. Design a lead compensator for a unity feedback open loop transfer function (14M)

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

having the damping coefficient 0.7, velocity error constant 2 sec^{-1} and settling time is 1.4 sec.

7. a) Consider the following system with differential equation is given by (7M)

$\dddot{y} + 4\ddot{y} + 9\dot{y} + 4y + u = 0$

Obtain the state space model in diagonal canonical form

b) Consider the system is defined by (7M)

$$\dot{x}(t) = \begin{bmatrix} a & b \\ c & d \end{bmatrix} x(t) + \begin{bmatrix} 1 \\ 1 \end{bmatrix} u(t)$$

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

Determine the conditions a, b, c and d for complete state controllability and complete observability

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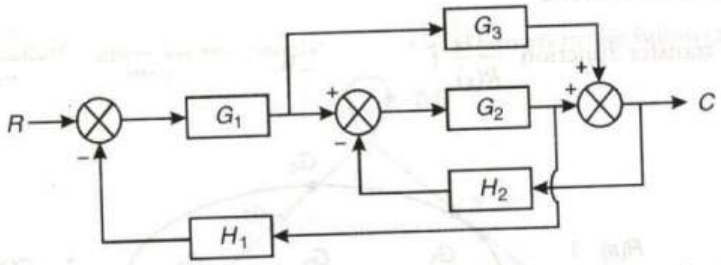
PART –A

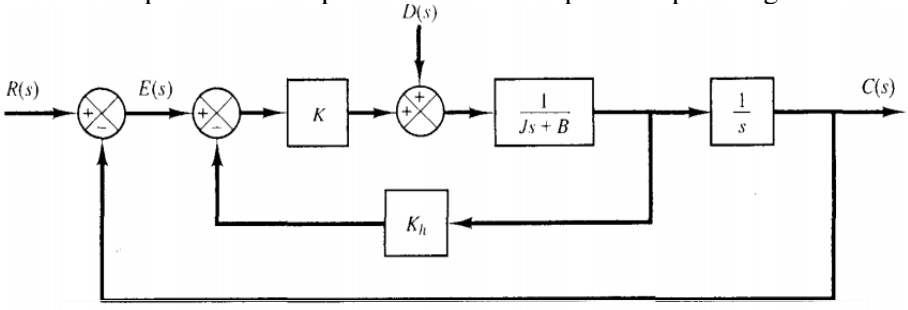
1. a) What is meant by non-touching loop in the signal flow graph? (2M)
   b) What are the general usages of Synchros? (2M)
   c) State any one special case in applying Routh-Hurwitz criterion? (2M)
   d) Consider the system, open loop transfer function $G(s)H(s) = e^{-sT}$ what is its magnitude and phase angle to draw a bode plot? (2M)
   e) What is the need for lag – lead compensator? (2M)
   f) Define what is meant by controllability? (2M)

PART -B

2. a) Explain the features of closed loop feedback system? What is the effect of sensitivity on positive and negative feedback systems? (7M)
   b) Identify the forward paths and individual loops and determine overall transfer function of the following block diagram? (7M)



3. a) Compare different characteristics of dc servomotor and ac servomotor? (7M)
   b) Consider the servo system with tachometer feedback shown in figure. Obtain the error signal *E(s)* when both the reference input *R(s)* and disturbance input *D(s)* are present. Obtain also the steady-state error when the system is subjected to a reference input is unit-ramp and disturbance input is step of magnitude'd'? (7M)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4. A single loop feedback system has open loop transfer function (14M)

$$G(s)H(s) = \frac{K(s+1)(s+2)}{(s^2 - 0.9s - 0.1)}$$

Sketch the root locus as a function of K, find the range of K for which system is stable and also find the K for which purely imaginary roots if exists and their roots?

5. a) Describe about the Nyquist contour and its various segments? (5M)

b) By using bode plot, determine the value of K for which the following open loop transfer function is having gain margin 15 dB and phase margin is 60^0? (9M)

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

6. a) Explain the procedure for designing lag compensator using root locus? (7M)

b) With neat diagram, explain the function of PID compensation in detail? (7M)

7. a) The state equation for the homogenous system is (7M)

$$\dot{X}(t) = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix} \begin{bmatrix} X_1(t) \\ X_2(t) \end{bmatrix}$$

Determine the solution of the system when $X(0) = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$

b) Obtain the state space representation of the transfer function (7M)

$$\frac{C(s)}{R(s)} = \frac{s^2 + 7s + 2}{s^3 + 9s^2 + 26s + 24}$$

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3. Answer any **FOUR** Questions from **Part-B**

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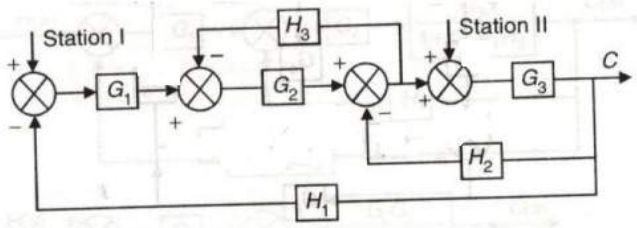
PART –A

1. a) What is meant by self-loop in the signal flow graph? (2M)
   b) In the position control system how the tachogenerator is used? (2M)
   c) What are drawbacks of R-H method (2M)
   d) Draw the phase plot of minimum and non-minimum phase systems? (2M)
   e) Under what circumstances lag compensator is preferred? (2M)
   f) What are the properties of state transition matrix? (2M)

PART -B

2. a) What is meant by sensitivity in the control system and discuss the effect of feedback on sensitivity? (7M)
   b) For the system represented by the block diagram is shown in the figure, evaluate the closed loop transfer function assuming the input R is present at station –II (7M)



3. a) Explain the principle of operation of synchro transmitter and receiver? (7M)
   b) Consider a unity-feedback control system with the closed-loop transferfunction (7M)

$$\frac{C(s)}{R(s)} = \frac{Ks+b}{s^2+as+b}$$

Determine the open-loop transfer function? show that the steady-state error in the unit-ramp response is given by $e_{ss} = \frac{1}{K_v} = \frac{a-K}{b}$

4. A feedback system has open loop transfer function (14M)

$$G(s)H(s) = \frac{K(s+6)^2}{s(s^2+1)(s+4)}$$

Sketch the root locus as a function of K, find the range of K for which system is stable and also find the K for which purely imaginary roots if exists and their roots?
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5. a) State and explain the Nyquit stability criterion (4M)

   b) Draw the bode plot for the open loop transfer function is given below and determine the gain margin and phase margin? (10M)

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

6. a) Explain the procedure for designing lead compensator using root locus? (7M)

   b) Explain the any one of the tuning procedure of the PID compensator? (7M)

7. a) State the concept of controllability and observability? (4M)

   b) Consider the system has the state space equation (10M)

$$\dot{X} = AX \; Where \; A = \begin{bmatrix} 3 & 1 & 0 \\ 0 & -2 & 1 \\ 1 & 2 & 0 \end{bmatrix}$$ Determine the STM