PVP 19

Code: 19EE3501

III B.Tech - I Semester – Regular Examinations – JANUARY 2022

CONTROL SYSTEMS ENGINEERING
(ELECTRICAL & ELECTRONICS ENGINEERING)

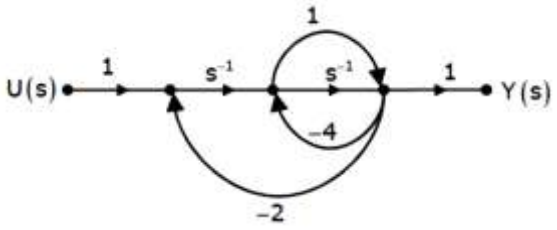
Duration: 3 hours Max. Marks: 70

Note: 1. This question paper contains two Parts A and B.
2. Part-A contains 5 short answer questions. Each Question carries 2 Marks.
3. Part-B contains 5 essay questions with an internal choice from each unit. Each question carries 12 marks.
4. All parts of Question paper must be answered in one place

PART – A

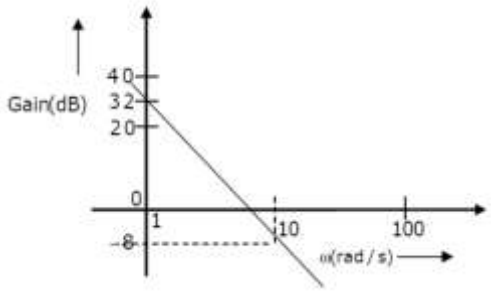
1. a) Compare closed loop and open loop systems.

b) Find the Transfer function, $\frac{Y(s)}{U(s)}$ for the given signal flow graph



c) Define any two time domain specifications.

d) The Bode plot of a transfer function G(s) is shown in the figure below.



The gain $(20log|G(s)|)$ is 32 dB and -8 dB at 1 radians/s and 10 radians/s respectively. The phase is negative for all ω. Then G(s) is

e) The state equations of a system are given by $\dot{x} = \begin{bmatrix} -1 & 1 \\ 0 & -3 \end{bmatrix} x + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$ and $y = [0 \quad 1]\, x$; then find the controllability and observability of the system.

PART – B

UNIT – I

2. a) Classify the control systems. 5 M

   b) Obtain the state variable representation of an armature-controlled DC Servo motor. 7 M

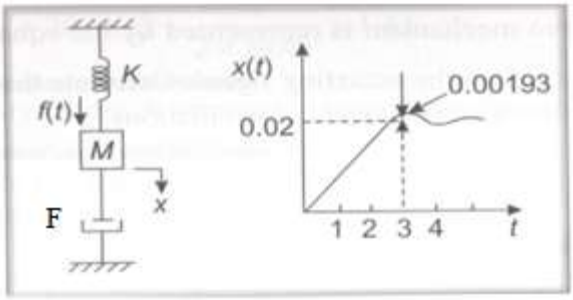
OR

3. a) With neat schematic diagram explain the synchro. Explain its application as an error detector. 7 M

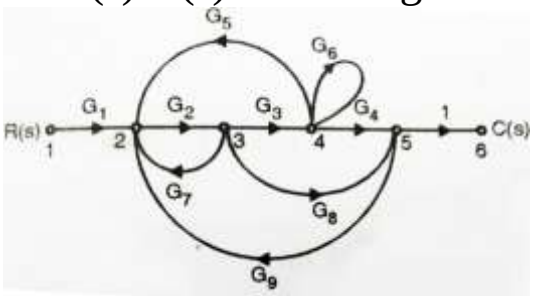
   b) With neat schematic diagram of DC servomotor and derive transfer function of it. 5 M

UNIT – II

4. a) Figure shows a mechanical system and the response when 10 N of force is applied to the system. Determine the values M, F and K. The dimension 'x' in meter. 6 M

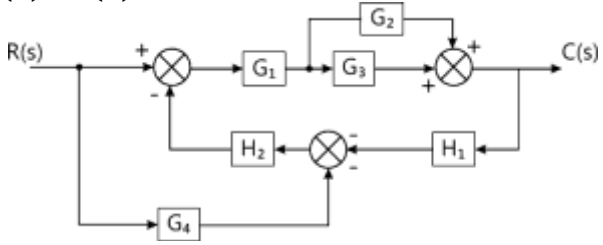


   b) Find overall gain C(s)/R(s) for the signal flow graph. 6 M

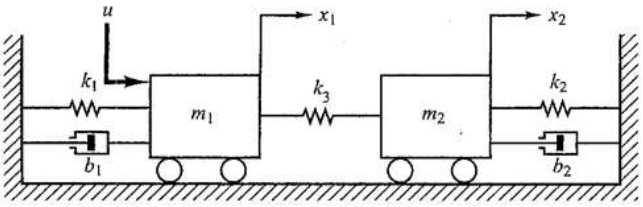


OR

5. a) For the system represented by the block diagram, determine C(s)/R(s) 6 M



   b) For the given mechanical, determine $X_1(s)/U(s)$ and $X_2(s)/U(s)$ 6 M



UNIT-III

6. a) A unity feedback system having an open loop transfer function $G(s) = \frac{k(S+13)}{S\,(3+S)(7+S)}$. Using Routh's stability criterion, find the range of *K* for the system to be stable. If K=1, check if all the poles of the closed loop transfer function have damping factor greater than 0.5. 6 M

b) A feedback control system is described as $\boldsymbol{G(s) = \frac{50}{S\,(S+2)(s+5)}}$ and $\boldsymbol{H(s) = \frac{1}{S}}$. Determine the static error coefficients for unity and non-unity feedback system. 6 M

OR

7. a) What is the significance of controllers in Control System? Discuss P, PI and PID controllers used in control systems with neat diagrams. 5 M

b) A unity feedback system has an open loop transfer function G(s) = $\frac{K(S+1)}{S(S-1)}$. Show that the root loci of complex roots are parts of a circle with (-1, 0) as center and radius of √2. Sketch the root locus with K as variable parameter. 7 M

UNIT – IV

8. a) The closed loop transfer function of a feedback system is

$$T(s) = \frac{44.4}{(s^2 + 2.45\,s + 44.4)}$$

(i) Determine the resonance peak and resonant frequency of the system by drawing the frequency response curve.

(ii) What should be the values of damping ratio and un-damped natural frequency Determine the bandwidth of equivalent second order system. 5 M

b) Sketch **bode plot** for the following transfer and determine the system gain **k** for the gain cross over frequency to be 5 rad/sec. 7 M

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

OR

9. a) Sketch the Nyquist plot for a system with open loop T.F. 6 M

$$\boldsymbol{G(s)H(s) = \frac{(S+1)(1+0.4S)}{(S-1)(1+8s)}}$$

b) Consider a unity feedback system having an open loop transfer function $\boldsymbol{G(s) = \frac{k}{S\,(1+0.2\,S)(1+0.05\,S)}}$. 6 M
Sketch the **polar plot** and determine the value of k so that Gain Margin = 18 db , and Phase Margin = 60^0

UNIT – V

10. a) Obtain Eigen values, Eigen vectors and the state model in canonical form for a system described by $\dot{X(t)} = Ax(t) + Bu(t)$ and $Y(t) = Cx(t) + Du(t)$
Where $A = \begin{bmatrix} 0 & 1 & 0 \\ 3 & 0 & 2 \\ -12 & -7 & -6 \end{bmatrix}, B = \begin{bmatrix} 1 \\ 0 \\ 2 \end{bmatrix}$, 6 M
$C = [1 \quad 0 \quad 0]$ and D = 0

b) Obtain controllable canonical representation for a system whose transfer function is given by
$\boldsymbol{\frac{Y(s)}{U(s)} = \frac{(6\,S^3 + 4\,S^2 + 3\,S + 10)}{(S^3 + 8\,S^2 + 4\,S + 20)}}$. 6 M

OR

11. a) A linear dynamic time invariant system with state equation $\dot{X} = Ax + Bu$ $A = \begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 0 & -2 & -3 \end{bmatrix}$,
$B = \begin{bmatrix} 0 & 1 \\ 0 & 0 \\ 1 & 0 \end{bmatrix}$. Find if the system is completely controllable or not. 6 M

b) Derive the state models for the system described by differential equation in controllable canonical form. 6 M

$$\boldsymbol{\dddot{y} + 4\,\ddot{y} + 5\,\dot{y} + 2\,y = 2\,\ddot{u} + 6\,\dot{u} + 5\,u}$$