GIET MAIN CAMPUS AUTONOMOUS GUNUPUR – 765022

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Total Number of Pages : 3 AR-17 B.TECH

B.TECH 5th SEMESTER EXAMINATIONS, NOV/DEC 2019

BELPC5040 CONTROL SYSTEM-II

EE BRANCH

Time : 3 Hours Maximum : 100 Marks

Answer ALL Questions

The figures in the right hand margin indicate marks.

PART – A: (Multiple Choice Questions) 10 x 2=20 Mark

Q.1. Answer *All* Questions

a The state equation of a system is $\dot{X} = AX + BU$, where $A = \begin{bmatrix}1 & 0\\1 & 1\end{bmatrix}$. The state transition matrix is **[CO4] [PO2]**

(a) $\begin{bmatrix}te^t & 0\\e^t & e^t\end{bmatrix}$ (b) $\begin{bmatrix}te^t & 0\\e^{-t} & e^{-t}\end{bmatrix}$ (c) $\begin{bmatrix}e^{-t} & 0\\te^{-t} & e^{-t}\end{bmatrix}$ (d) $\begin{bmatrix}e^t & 0\\te^t & e^t\end{bmatrix}$

b The term backlash is associated with **[CO3] [PO1]**

(a) Servomotors (b) Induction relays (c) Gear trains (d) Tacho generators

c The stability of non-linear system **[CO1] [PO1]**

(a) Disturbed steady state coming back to its equilibrium state.
(b) Nonlinear system to be in closed trajectory.
(c) In limit cycle that is oscillations of the systems.
(d) All of the above.

d The visual analogy of the Lyapunov energy description is **[CO1] [PO1]**

(a) Ellipse (b) Circle (d) Square (d) Rectangle

e Conditions of ________ are necessary and sufficient condition for the asymptotic stability of the system. **[CO3] [PO1]**

(a) Linear system (b) Krasovskii's method c) Positive definiteness (d) Variable gradient method

f Electrical time-constant of an armature-controlled dc servomotor is **[CO1] [PO2]**

(a) Equal to mechanical time constant (b) Smaller than mechanical time constant
(c) Larger than mechanical time constant (d) Not related to mechanical time constant

g The system $\dot{X}(t) = AX(t) + BU(t)$ with $A = \begin{bmatrix}-1 & 2\\0 & 2\end{bmatrix}$ and $B = \begin{bmatrix}0\\1\end{bmatrix}$ is **[CO4] [PO2]**

(a) Unstable and uncontrollable (b) Stable but uncontrollable
(c) Unstable but controllable (d) Stable and controllable

h Laplace Transform is not applicable to nonlinear system because **[CO1] [PO1]**

(a) Nonlinear systems are time varying
(b) Time domain analysis is easier than frequency domain analysis
(c) Initial conditions are not zero in nonlinear systems
(d) Super-position law is not applicable to nonlinear system

i For nonlinear systems the equation for damping factor as in linear system is called **[CO3] [PO1]**

(a)Krasovskii's equation(b)Vander Pol's equation (c)Constant method (d)Non-variable gradient method

j The transfer function for the state variable representation $\dot{X} = AX + BU$, $Y = CX + DU$ is given by **[CO4] [PO2]**

(a) $D + C(SI - A)^{-1}B$ (b) $B(SI - A)^{-1}C + D$ (c) $D(SI - A)^{-1}B + C$ (d) $C(SI - A)^{-1}D + B$

PART – B: (Short Answer Questions) 10X2=20 Marks

Q.2. Answer *ALL* questions

a What are the different types of limit cycle depending on the pattern of the trajectories in the vicinity? Explain with diagrams. **[CO1] [PO1]**

b Draw a block diagram representing the state model of a single input single output linear system. **[CO4] [PO1]**

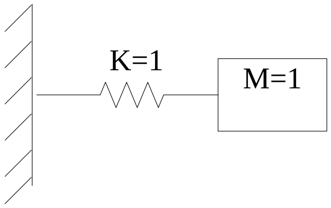
c Draw the phase trajectory of first order system $\dot{x} = -4x + x^3$. **[CO4] [PO2]**

d Compute the unit step response of a discrete time system with transfer function $G_q(z) = \frac{0.5z^2 - 1.2z + 0.7}{z^3}$. **[CO3] [PO2]**

e Write short notes on Lyapunov's second method. **[CO1] [PO1]** f Determine the conditions on b_1, b_2, d_1, d_2 so that the system is completely controllable and observable. **[CO4] [PO2]**

$$\dot{X} = \begin{bmatrix} 1 & 1 \\ 0 & 1 \end{bmatrix} X + \begin{bmatrix} b_1 \\ b_2 \end{bmatrix} U \qquad C = [d_1 \quad d_2] X$$

g Draw the phase portrait of a mass-spring system as shown in the figure. **[CO3] [PO1]**



h Construct the phase trajectory for the following equation: **[CO4] [PO2]**

$$\ddot{x} + |\dot{x}|\dot{x} + x = 0$$

i Predict the stability of the following system: **[CO1] [PO2]**

$$F(Z) = 8Z^4 + 4Z^3 + 2Z^2 + 4Z$$

j Explain the Shannon's sampling theorem. **[CO3] [PO1]**

PART – C: (Long Answer Questions) 4X15=60 Marks

Answer *ALL* questions

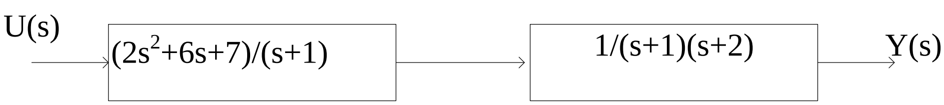
Q.3

a Find the solution of state equation: $\dot{X} = AX + BU$. 7 **[CO4] [PO1]**

b Given matrix $A = \begin{bmatrix} 1 & 4 & 10 \\ 0 & 2 & 0 \\ 0 & 2 & 3 \end{bmatrix}$. Find out the matrix M so that $M^{-1}AM$ is a diagonal matrix. Also find the diagonal matrix. 8 **[CO1] [PO2]**

OR

c Write down the canonical state variable form for the system given below and draw the block diagram in state variable form. 8 **[CO4] [PO1]**



d Consider a linear system described by the equations: 7 **[CO1] [PO2]**

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

$$Y = [0 \quad 0 \quad 1] X$$

Design a state observer matrix G so that the Eigen values of the matrix (A-GC) are at -4, (-3+j1), (-3-j1).

Q.4

a Obtain the Z-transform: 8 **[CO3] [PO2]**

i) $f(t) = te^{-at}$ ii) $F(s) = \frac{b}{s(s+b)}$

b Describe the state space model for the line at sampled data control system which can be described by the following difference equation. 7 **[CO4] [PO1]**

$$y[(k+2)T] + 2y[(k+1)T] + y(kT) = u(kT)$$

OR

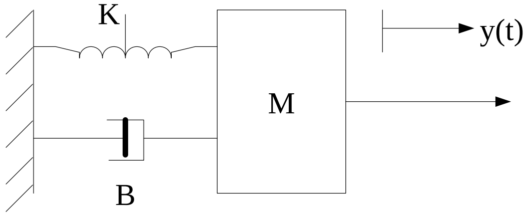
c Find out the inverse transform for 10 **[CO3] [PO2]**

i) $F(z) = \frac{z(1-e^{-aT})}{(z-1)(z-e^{-at})}$ ii) $F(z) = \frac{z(z+1)}{(z-1)^3}$

d Explain Jury's test of stability. 5 **[CO1] [PO1]**

Q.5

a Find out the transfer functions and draw its SFG of the following system. 7 **[CO1] [PO1]**



b In case of a simple pendulum, the equation of the motion is $\ddot{X} + \frac{g}{l}\sin x = 0$. Draw the phase trajectory. 8 **[CO4] [PO2]**

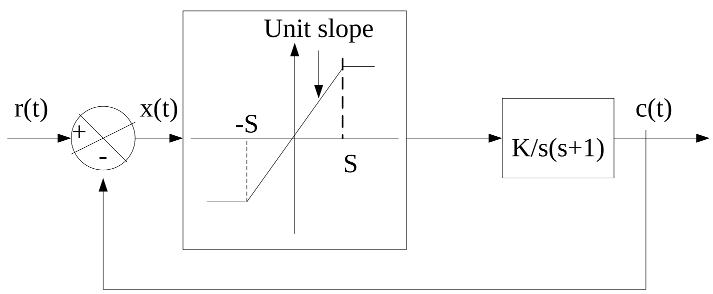
OR

c Describe different common physical nonlinearities. 10 **[CO3] [PO1]**

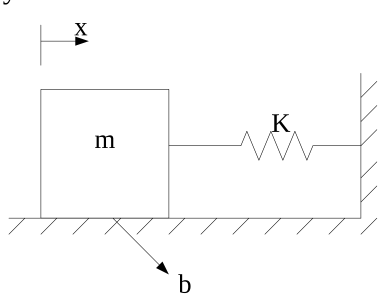
d Describe the Isocline method. 5 **[CO1] [PO1]**

Q.6

a Obtain the frequency response of the system with saturation nonlinearity shown in the figure. Given K=150, S=2, R=1.5. (Use graph paper) 10 **[CO1] [PO2]**



b A simple mass, spring and viscous friction system is shown in the figure. Show that the system is stable. 5 **[CO3] [PO1]**



OR

c Using Lyapunov's method, investigate the stability of the system: 8 **[CO1] [PO1]**

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}0 & 1\\ -1 & -1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

d Determine the stability of the system described by the following equations: 7 **[CO4] [PO2]**

$\dot{X} = AX$,$A = \begin{bmatrix}-1 & -2\\ 1 & -4\end{bmatrix}$

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