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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belagavi)

Fifth Semester, B.E. - Electronics and Communication Engineering

Semester End Examination; Dec - 2017 /Jan - 2018

Control Systems

Time: 3 hrs *Max. Marks: 100*

Note*: Answer* ***FIVE*** *full questions, selecting* ***ONE*** *full question from each Unit.*

UNIT - I

1 a. Define control system. Distinguish between open loop and closed loop control systems with suitable examples. 6

b. For the system shown in Fig. 1.b write its mechanical network and obtain mathematical model and electrical analogue based on force-current analogy. 8

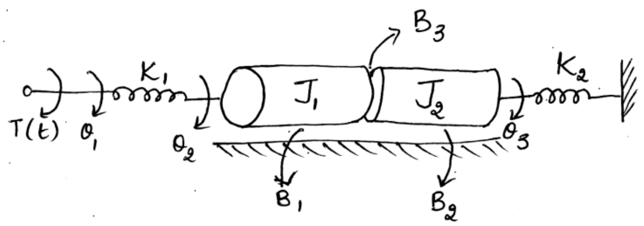


Fig. 1.b.

c. Define transfer function and list advantages and disadvantages of transfer function. 6

2 a. Draw F-V and F-I analogous circuits for the mechanical system shown in Fig. 2.a with necessary equations. 12

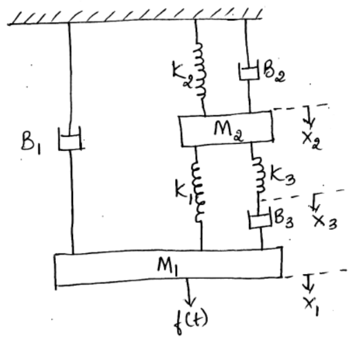


Fig. 2.a.

b. Find the transfer function $\frac{X(S)}{E(S)}$ for the electro mechanical system shown in Fig. 2.b. 8

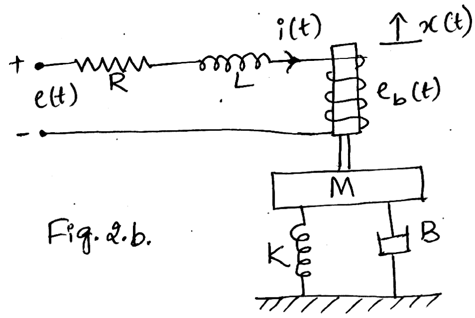


Fig. 2.b.

UNIT - II

3 a. Obtain the transfer function for the block diagram shown in Fig. 3.a using block diagram reduction technique. 12

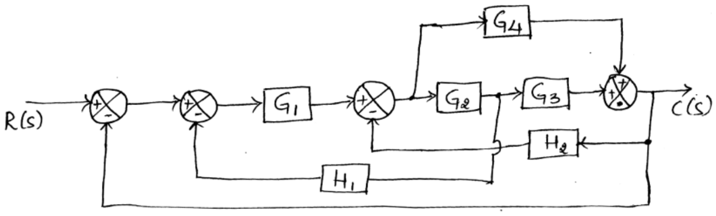


Fig.3.a.

b. Find the overall transfer function by block diagram reduction technique for the signal flow graph shown in Fig. 3.b. and verify the result by Mason's gain formula. 8

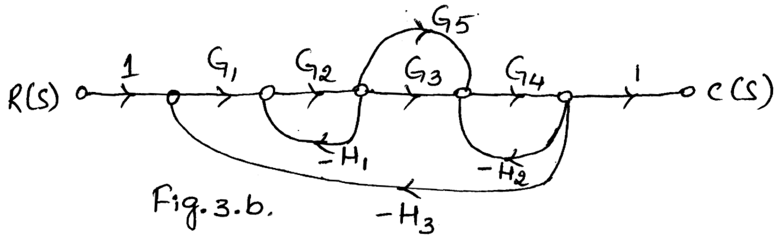


Fig.3.b.

4 a. Derive expression for peak response time (t_p), rise time (t_r) maximum overshoot (M_P) of an under damped second order control system subjected to step input. 10

b. For a unit feedback system with: $G(S)=\dfrac{10(S+2)}{S^2(S+1)}$

Find; i) The static error coefficients 6

ii) Steady state error when the input is $R(S)=\dfrac{3}{S}-\dfrac{3}{S^2}+\dfrac{1}{3S^3}$

c. The response of servo mechanism is $c(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$ when subjected to a unit step input. Obtain an expression for closed loop transfer function. Determine the undamped natural frequency and damping ratio. 4

UNIT - III

5 a. Investigate the stability of the system given by characteristic equation 8

$S^6 + 2S^5 + 8S^4 + 12S^3 + 20S^2 + 16S + 16 = 0$

b. Unity feedback control system is characterized by the open loop transfer function

$G(S)=\dfrac{K(S+13)}{S(S+3)(S+7)}$

i) Using the Routh's criterion, calculate the range of values of K for the system to be stable. 8

ii) check if K = 1, all the roots of the characteristic equation of the above system are more negative than -0.5

c. List the limitations of R-H criterion. 4

6 a. Sketch the root locus. for the unity feedback control system whose open loop transfer function is $G(S)H(S)=\dfrac{1}{S(S+2)(S^2+4S+13)}$. 12

b. Show that the root loci for unity feedback control system with $G(S)=\dfrac{K(S^2+6S+10)}{(S^2+2S+10)}$ are the arcs of circle of radius $\sqrt{10}$ and centered at the origin. 8

UNIT-IV

7 a. Construct the bode plots for a unity feedback control system having $G(S)=\dfrac{2000}{S(S+1)(S+100)}$ From the bode plot.

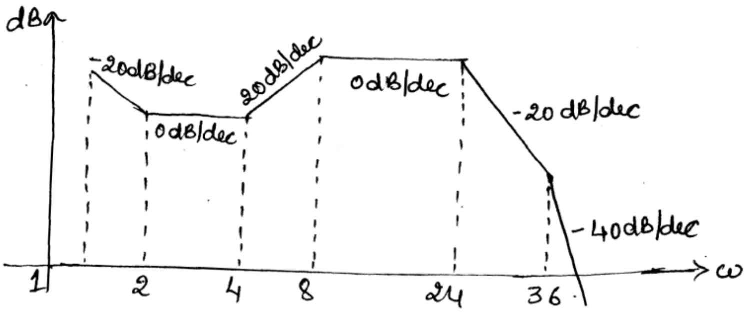
Determine; 14

i) Gain Crossover frequency ii) Phase crossover frequency

iii) Gain margin iv) Phase margin.

Comment on stability.

b. Find the transfer function for the plot of the asymptotic magnitude (in dB) versus frequency (log scale) shown in Fig. 7.b. 6



8 a. Sketch Nyquist plot for a system whose open transfer function is $G(S)H(S)=\dfrac{K(4S+1)}{S(2S-1)}$ 14

Determine the range of K for which the system is stable.

b. Plot the polar plot for the transfer function $G(S)=\dfrac{1}{S(TS+1)}$. 6

UNIT-V

9 a. Develop a state model for the electrical network shown in fig. 9(a) choosing the current through the inductance and voltage across the capacitor as states. The output is

$Y=\begin{bmatrix}V_{R_2} & i_{R_2}\end{bmatrix}^T$. 10

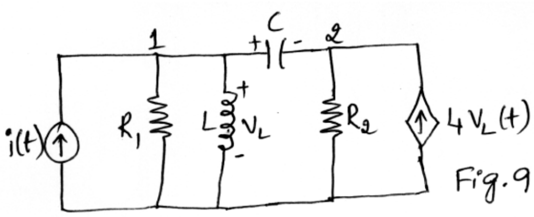


Fig.9.a

b. A System is described by the differential equation

$\frac{d^3y}{dt^3}+\frac{3d^2y}{dt^2}+\frac{17dy}{dt}+5y=10u(t)$, where y is the output and u is the input to the system. 6

Determine the state space representation of the system.

c. Define the following terms : 4

i) State ii) State variable iii) State space iv) State trajectory

10 a. Determine the state controllability and observability of the system described by : 10

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

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

b. Obtain the transfer function for a control system given by : 10

$$\frac{y(s)}{u(s)}=\frac{s^2+3s+4}{s^3+2s^2+3s+2}.$$

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