U.S.N

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

(An Autonomous Institution affiliated to VTU, Belagavi)

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

Semester End Examination; Dec - 2017/Jan - 2018

Linear Control Systems

Time: 3 hrs *Max. Marks: 100*

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

UNIT - I

1 a. Fig. 1(a) shows self operated control system used in overhead/sump water tank using floating ball. Explain its operation with block diagram. 5

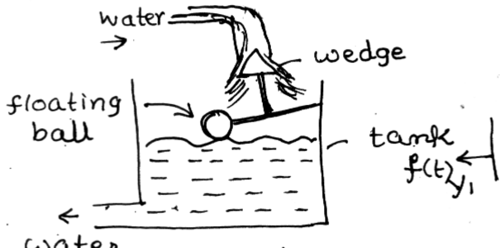

Fig 1 a)

b. What are the advantages of closed loop control systems over open-loop control systems? 5

c. Obtain the transfer function of armature controlled DC servomotor. 10

2 a. A vehicle towing a trailer through a spring damper coupling hitch is shown in Fig. 2 (a). The following parameters and variables are defined: M is the mass of the hitch, K_h the spring constant of the hitch, B_h the viscous friction coefficient of the hitch, B_t is the trailer. y_1 is the displacement of towing vehicle, and y_2 is the displacement of towing trailer and *f(t)* the force of the towing vehicle. Write the differential equation of the system. 5

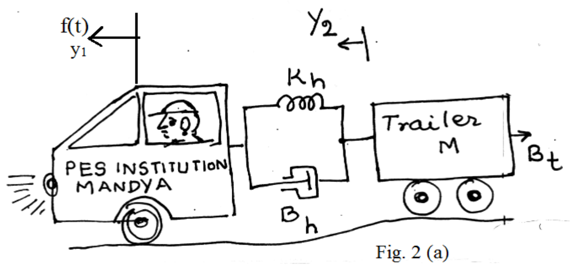

Fig. 2 (a)

b. For the system represented by the block diagram shown in Fig. 2(b) evaluate the closed loop transfer function. 10

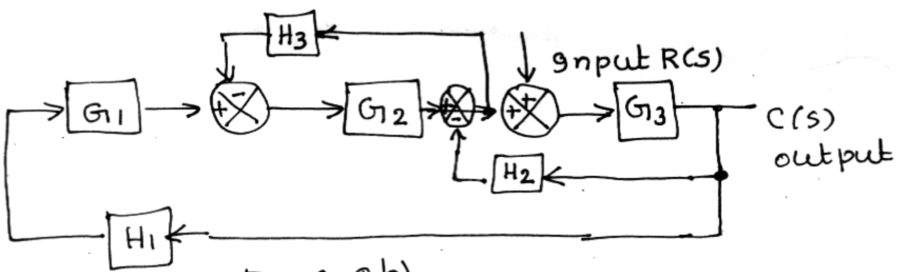

Fig Q 2b)

c. Count number of forward paths and loops and find their gains for Fig. Q 2(c). 5

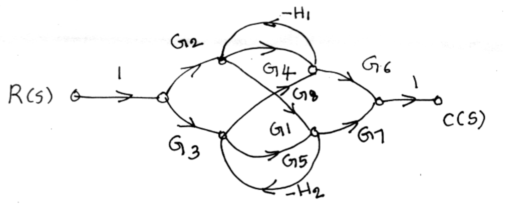

Fig Q 2C)

UNIT - II

3 a. A first order system and its response to a unit step input are shown in Fig. Q 3(a). Find the system parameters '*a*' and *k*. 10

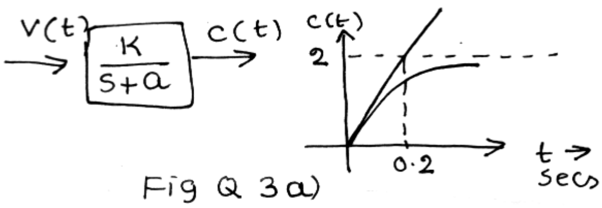

Fig Q 3a)

b. Find the values ω_d, M_p and t_r of second order system, given $\xi = 0.5$, and angular frequency of oscillation $\omega_n = 1.414$ rad/sec. 10

4 a. Define find static error coefficients K_p, K_v and K_a. 5

b. For what values of '*a*' does the system shown in Fig. Q 4(b) have a zero steady state errors for a step input. 10

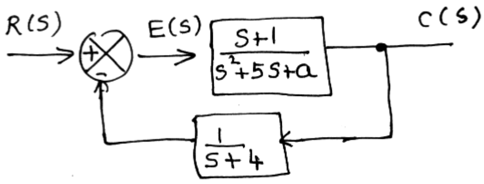

Fig Q 4b)

c. The step response of a unity feedback control system is given by *c(t) = 1-1.66e-8t sin(6t+37º)*. Find the closed loop transfer function. 5

UNIT - III

5 a. Consider the following Routh table. Notice that the S^5 row was originally all zeros. Tell how many roots of the original polynomial were in the right half of a plane, and on jw axis. 10

S^7	1	2	-1	-2
S^6	1	2	-1	-2
S^5	3	4	-1	0
S^4	1	-1	-3	0
S^3	7	8	0	0
S^2	-15	-21	0	0
S^1	-9	0	0	0
S^0	-21	0	0	0

b. A negative feed back control system is characterisrised by,

$$G(S)H(S)=\frac{Ke^{-S}}{S\left(S^2+5S+9\right)}$$ 10

Determine the maximum value of K for stability.

6 a. Sketch the general shape of the root locus for each of the open-loop pole- zero plot shown in Fig. Q6(a). 5

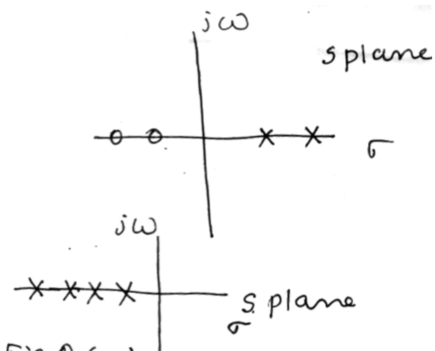

Fig Q6 a)

b. Construct root-locus for the following open-loop transfer function,

$$G(S)H(S)=\frac{K\left(S+2\right)}{S\left(S+1\right)\left(S+8\right)}$$ 15

Show all necessary calculations worked out.

UNIT - IV

7 a. Derive the expression for resonant peak M_r and bandwidth ω_b respect to frequency domain. 5

b. For the given open-loop transfer function,

$$G(S)H(S)=\frac{10}{S\left(S+1\right)\left(0.1S+1\right)}$$

i) Draw the Bode diagram 15

ii) Mark the Phase margin and Gain margin

iii) Record the gain cross over frequency and phase cross over frequency

iv) Is the system stable?

8 a. Write the procedure to draw the Bode magnitude plot. 5

b. Find open-loop transfer function from the magnitude plot shown in Fig. Q8(b). 15

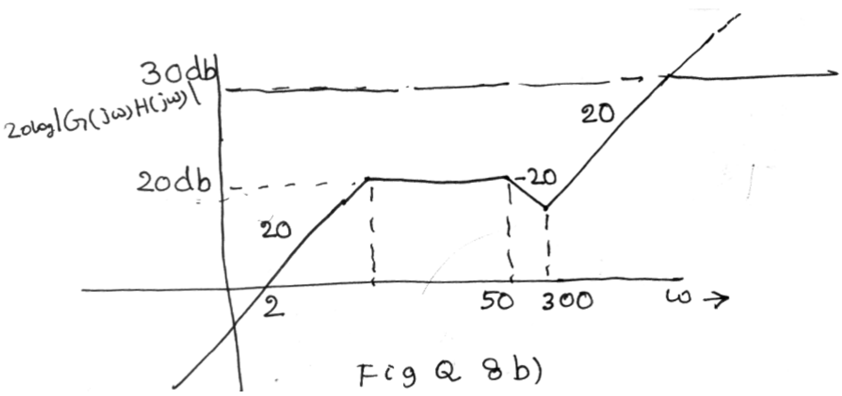

Fig Q 8 b)

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UNIT - V

9 a. State Nyquist criterion of stability. 5

b. Define Gain Margin, Phase Margin (PM) with respect to polar plot. 5

c. The following polar Nyquist plot is the sketch of the map of the positive imaginary axis of the S-plane. G(S) has no poles in the right half of the S-plane.

i) Complete the plot – i.e. add the map of the negative imaginary axis and any required closing circular arcs.

ii) Is the system stable?

iii) What is the system Type number? 10

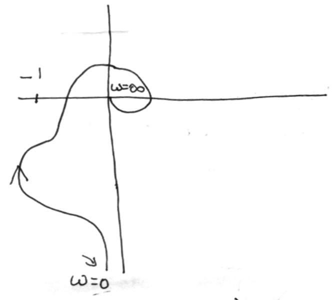

Fig Q 9c)

10. An open loop transfer function is given by:

$$G(S)H(S) = \frac{100}{S(S+1)(S+2)}$$ 20

Using Nyquist criterion. Check stability of the control system Record GM, PM, ω_g, ω_{pc}.

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