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

(An Autonomous Institution affiliated to VTU, Belagavi)

Seventh Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec - 2017/Jan - 2018

Automatic Control Engineering

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each unit.*
ii) Assume suitably missing data if any.

UNIT - I

1 a. Explain the elements of feedback control system with a neat block diagram. 8

b. Find $\frac{X(S)}{E_1(S)}$ for the system shown in Fig. Q1(b), where $E_1(t)$ is input voltage while $x(t)$ is the output displacement. 12

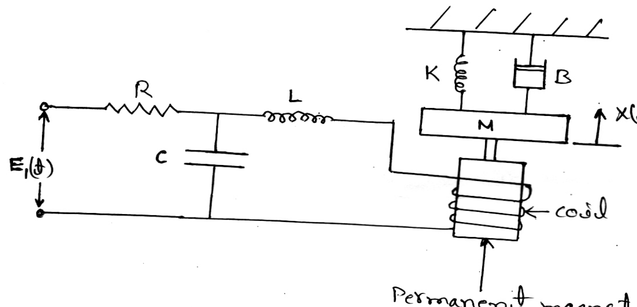

Fig. Q1(b)

2 a. With a neat sketch, explain liquid level control system. 10

b. Derive the differential equation for a DC motor with load (armature controlled). 10

UNIT - II

3 a. Explain any four block diagram reduction rules. 8

b. Evaluate C/R_1 and C/R_2 for a system whose block diagram representation is shown in Fig. Q3(b) where R_1 is the input to summing point No.1. 12

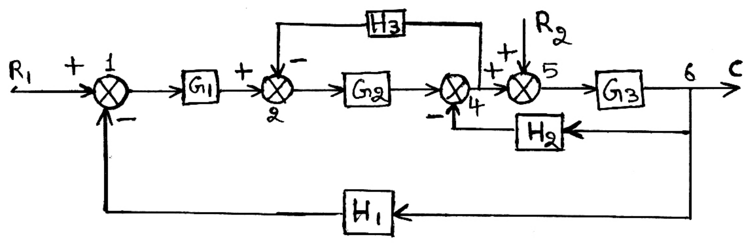

Fig. Q3(b)

4 a. Draw the signal flow graph of a system described by the following set of equations, where R is the input variable and x_5 is the output variable. Determine the overall transfer function using Mason's gain formula. 8

$x_1 = R - x_5$, $x_2 = x_1 - H_1x_4$, $x_3 = G_1x_2 - H_2x_5$, $x_4 = G_2x_3$, $x_5 = G_3x_4 + G_4x_2$.

b. Draw the SFG (Signal Flow Graph) for the block diagram shown in Fig. Q4(b) and obtain, $\frac{C(S)}{R(S)}$ using Mason's gain formula. 12

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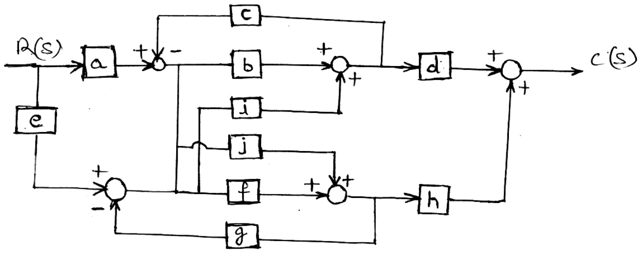

Fig. Q4(b).

UNIT - III

5 a. Obtain the unit step response expression of a second order underdamped system and show its response curve. 8

b. A Mercury in glass thermometer has an overall transfer function $\frac{A}{S+A}$. If the thermometer requires 1 minute to indicate a 95% of its final value for a unit step excitation determine the value of *A*. 6

c. Obtain the unit Impulse response and the unit step response of a unity feedback system whose open loop transfer function is given by $G(S)=\frac{2S+1}{S^2}$. 6

6 a. Obtain static error coefficient for a unit feedback system whose open loop transfer function is $G(S)=\frac{10(1+S)}{S^2(6+5S)}$. Also find steady state error to an input $r(t)=1+4t+t^2$. 8

b. The transfer function of a system is given by $\frac{C(S)}{R(S)}=\frac{10(S+2)}{S^2+9S+18}$. Determine *C(t),* where *R(t)* is the unit step input. 4

c. The characteristic equation of a feedback control system is $S^4+20KS^3+5S^2+10S+15=0$. Find the range of *K* for which system is stable. 8

UNIT - IV

7 a. Draw the rough nature of Polar plots for the following transfer functions :

$(i)\ G(S)=\frac{K}{1+T_1 j\omega}$ $\quad (ii)\ G(S)=\frac{K}{(1+T_1 j\omega)(1+T_2 j\omega)}$ $\quad (iii)\ G(S)=\frac{K}{S(1+T_1 j\omega)(1+T_2 j\omega)}$. 6

b. A unity feedback control system has $G(S)=\frac{10}{S(S+1)(S+2)}$. Draw Nyquist plot and comment on closed loop stability. 14

8 a. Explain Nyquist stability criterion. 4

b. Sketch the Bode plot and determine the gain cross-over and phase cross-over frequencies for the system whose $G(S)=\frac{10}{S(1+0.5S)(1+0.1S)}$. 16

UNIT - V

9. Sketch the root locus plot for a control system represented by $G(S)H(S)=\frac{K}{S(S+2)(S^2+4S+8)}$. 20

10 a. Obtain the state equation and output equation of rotational system shown in Fig. Q10(a). 8

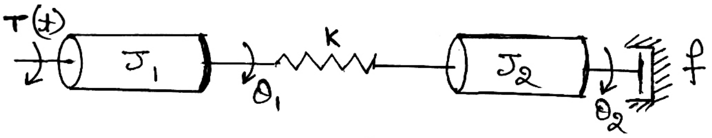

Fig. 10 (a)

b. Write short notes on : 8

(i) Controllability (ii) Observability.

c. A system is defined by the equation $\dddot{y}+a_1\ddot{y}+a_2\dot{y}+a_3 y=bu$, where *y* is the output and *u* is the input of the system. Obtain state equation and output equation of the system. 4

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