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21EE52

Fifth Semester B.E. Degree Examination, June/July 2024
Control Systems

Time: 3 hrs. Max. Marks: 100

Note: Answer any FIVE full questions, choosing ONE full question from each module.

Module-1

1 a. Define Control System? What are the requirements of a good control system? **(06 Marks)**

b. Obtain the transfer function of the given network shown in Fig.Q.1(b). **(06 Marks)**

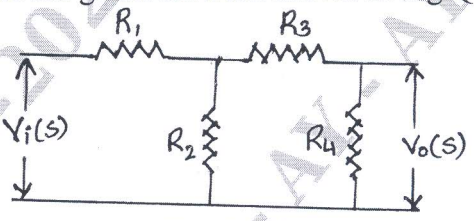

Fig.Q.1(b)

c. For the system shown in Fig.Q.1(c), draw the electrical network based on torque current analogy give all the performance equation **(08 Marks)**

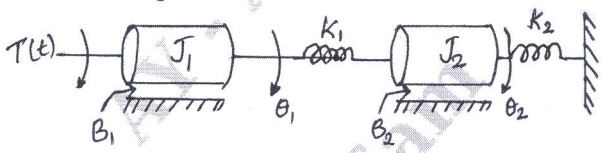

Fig.Q.1(c)

OR

2 a. For the mechanical system shown in Fig.Q.2(a). Draw the mechanical network and obtain the FV analogous electrical systems. **(08 Marks)**

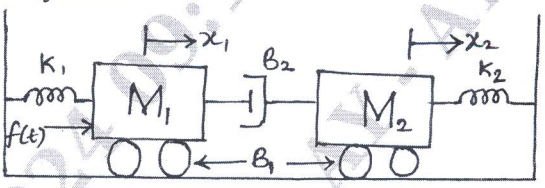

Fig.Q.2(a)

b. Derive the transfer function of an armature controlled dc motor. **(06 Marks)**

c. Explain the procedure to plot the synchro pair characteristics of synchronous receiver and transmitter. **(06 Marks)**

Module-2

3 a. Determine $\frac{C(S)}{R(S)}$ using block diagram reduction technique shown in Fig.Q.3(a). **(10 Marks)**

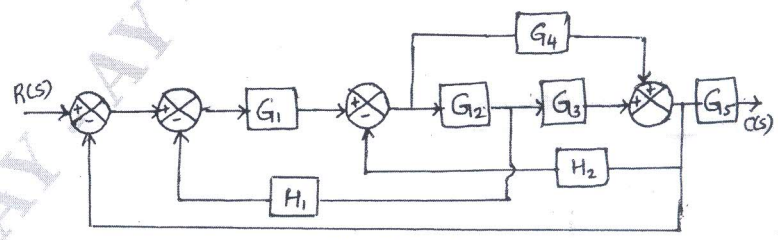

Fig.Q.3(a)

b. State Mason's gain formula. Draw the signal flow graph and find the transfer function shown in Fig.Q.3(b) **(10 Marks)**

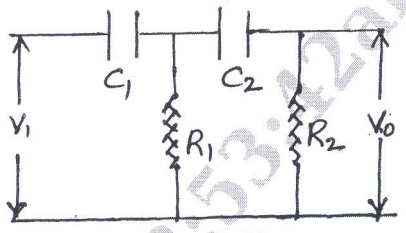

Fig.Q.3(b)

OR

4 a. Explain the following terms in block diagram reduction:
i) Moving a summing point after a block.
ii) Moving a branch point (take off point) ahead of a block.
iii) Eliminating a forward path.
iv) Interchanging a summing point and take off point. **(10 Marks)**

b. Draw the signal flow graph for the system described by the following set of equations and obtain the ratio of output x_o to input x_i using Mason's gain formula.

$x_2 = x_1 - x_6$
$x_3 = G_1x_2 - H_2x_4 - H_3x_5$
$x_4 = G_2x_3 - H_6x_6$
$x_5 = G_3x_4$
$x_6 = G_4x_5$ **(10 Marks)**

Module-3

5 a. Derive an expression for response of second order underdamped system for unit step input. **(06 Marks)**

b. The closed loop transfer function of a second order system is $\frac{C(S)}{R(S)} = \frac{25}{s^2+6s+25}$. Find rise time, Peak time, maximum overshoot and settling time, if the system is subjected to unit step input. Assume allowable steady state error as 2%. **(08 Marks)**

c. State R-H criterion, explain the difficulties of R-H criterion and remedy. **(06 Marks)**

OR

6 a. Explain the performance characteristics of transient response specifications to unit step input. **(06 Marks)**

b. A unity feedback system having open loop transfer function of $G(S) = \frac{K(2S+1)}{S(S+1)(S+4)^2}$. The input r(t) = 1 + 6t is applied to the system. Determine the minimum value of K. If the steady state error is to be less than 0.1. **(08 Marks)**

c. Check the stability of the given characteristic equation using R-H criterion
$S^5 + 2S^4 + 4S^3 + 6S^2 + 2S + 5 = 0$. **(06 Marks)**

Module-4

7 a. Sketch the root locus plot for the system whose OLTF is given by $G(S)H(S) = \frac{K}{(S+1)(S+3)(S+5)}$. Find the value of K for which the system is stable. Also show the line of RLP for damping ratio $\xi = 0.5$. **(10 Marks)**

b. Explain with circuit diagram and procedure to determine experimentally the frequency response of a second order system and evaluation of frequency domain specifications. **(10 Marks)**

OR

8 a. A unity feedback control system with $G(S)=\frac{10(S+10)}{S(S+2)(S+5)}$ find gain and phase margin using bode plot. **(10 Marks)**

b. Derive an expression for resonant peak and resonant frequency for a second order system. **(10 Marks)**

Module-5

9 a. State and explain the Nyquist stability criterion. **(06 Marks)**

b. Explain PI and PID controller on a second order system. **(08 Marks)**

c. Explain the step by step procedure of lead compensating network. **(06 Marks)**

OR

10 a. The open loop transfer function of a control system is $G(S)H(S)=\frac{1}{S^2(S+2)}$ sketch the Nyquist plot. Comment on stability. **(10 Marks)**

b. What is lead-lag compensation? Explain the procedure to design lead-lag compensation in frequency domain. **(10 Marks)**

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