USN

21EC43

Fourth Semester B.E. Degree Examination, Dec.2023/Jan.2024

Circuits and Controls

Time: 3 hrs. Max. Marks: 100

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

Module-1

1 a. Find the power delivered to 4 Ω Resistor shown in Fig. Q1 (a) using mesh analysis. **(07 Marks)**

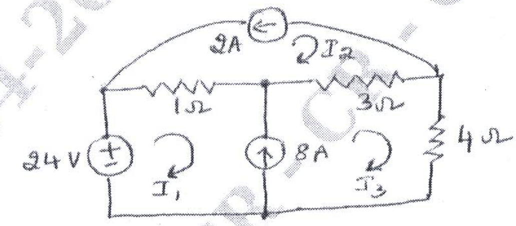

Fig. Q1 (a)

b. Find the Thevinin's equivalent circuit shown in Fig. Q1 (b) with respect to terminals a - b. **(07 Marks)**

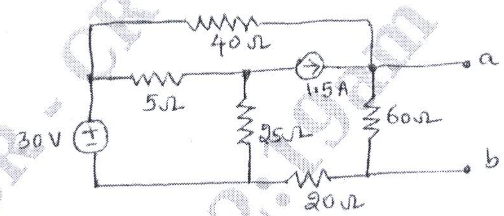

Fig. Q1 (b)

c. Explain superposition and Thevinin's theorems. **(06 Marks)**

OR

2 a. For the circuit shown in Fig. Q2 (a), find the voltage V_x. Use nodal analysis. **(07 Marks)**

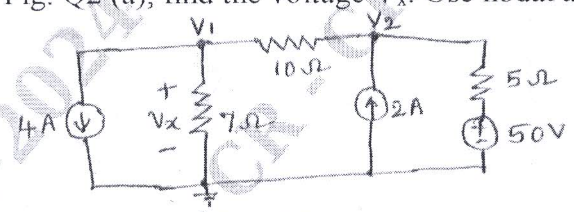

Fig. Q2 (a)

b. State and prove maximum power transfer theorem for DC circuits. **(06 Marks)**

c. Find the maximum power dissipated in R_L shown in Fig. Q2 (c).

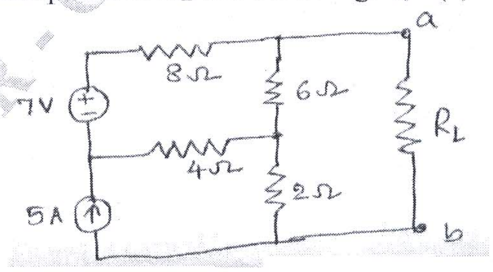

Fig. Q2 (c) **(07 Marks)**

Module-2

3 a. State and prove initial and final value theorems. **(06 Marks)**

b. Find Laplace transform of f(t) shown in Fig. Q3 (b).

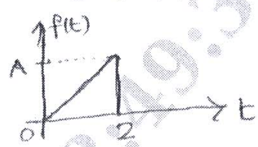

Fig. Q3 (b) **(07 Marks)**

c. Determine z-parameters for the network shown in Fig. Q3 (c).

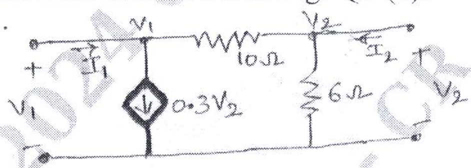

Fig. Q3 (c) **(07 Marks)**

OR

4 a. Find Laplace transform of unit impulse, unit step and unit ramp functions. **(06 Marks)**

b. For the circuit shown in Fig. Q4 (b). Find i(t). Assume $V_C(0) = 10$ V and $i(0) = 0$ A.

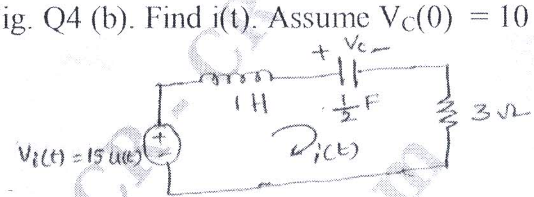

Fig. Q4 (b) **(07 Marks)**

c. Find h-parameters for the circuit shown in Fig. Q4 (c).

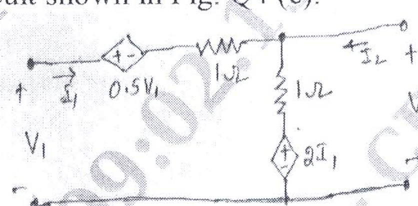

Fig. Q4 (c) **(07 Marks)**

Module-3

5 a. For the signal flow graph shown in Fig. Q5 (a), find $\frac{C(s)}{R(s)}$ by using Mason's gain formula. **(08 Marks)**

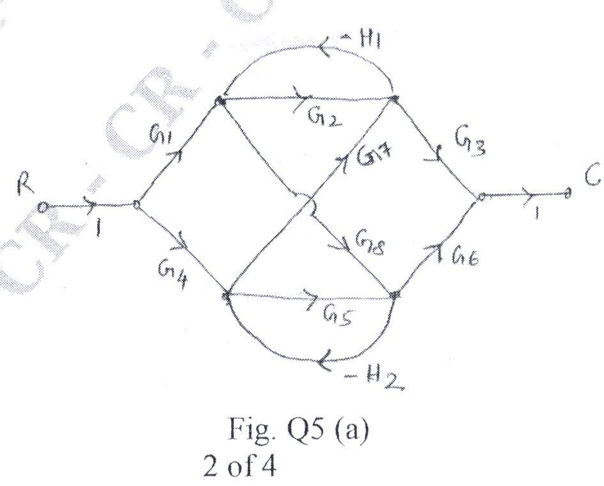

Fig. Q5 (a)

b. Explain Mason's gain formula. **(04 Marks)**

c. Reduce the block diagram, shown in Fig. Q5 (c) and find $\frac{C(s)}{R(s)}$ by using block diagram reduction techniques.

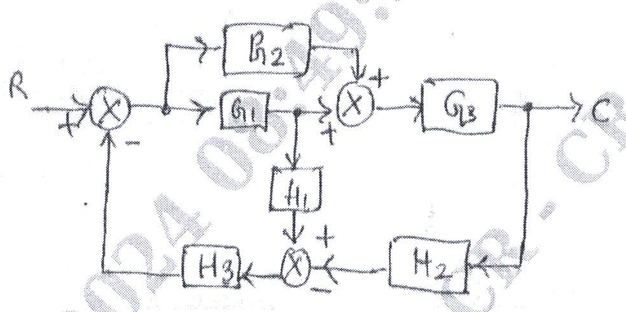

Fig.Q5 (c)

(08 Marks)

OR

6 a. Explain with a specimen signal flow graph the following :
   (i) Forward path and forward path gain.
   (ii) Loop and loop gain.
   (iii) Non touching loops.
   (iv) Input and output nodes. **(04 Marks)**

b. Find $\frac{C(s)}{R(s)}$ for the signal flow graph shown in Fig. Q6 (b).

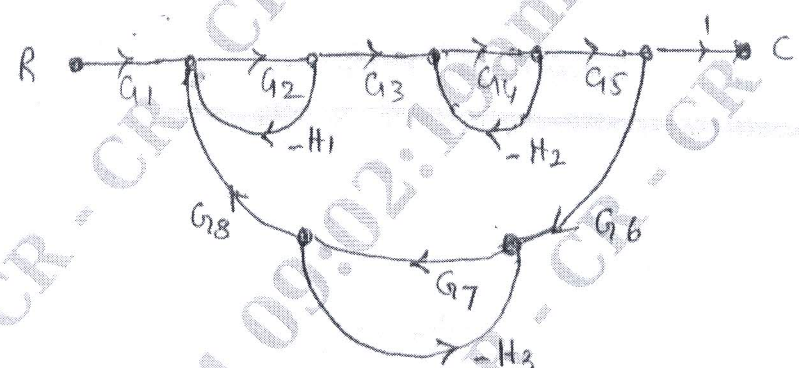

Fig. Q6 (b)

(08 Marks)

c. Find $\frac{C}{R}$ for the block diagram, shown in Fig. Q6 (c) using block diagram reduction technique.

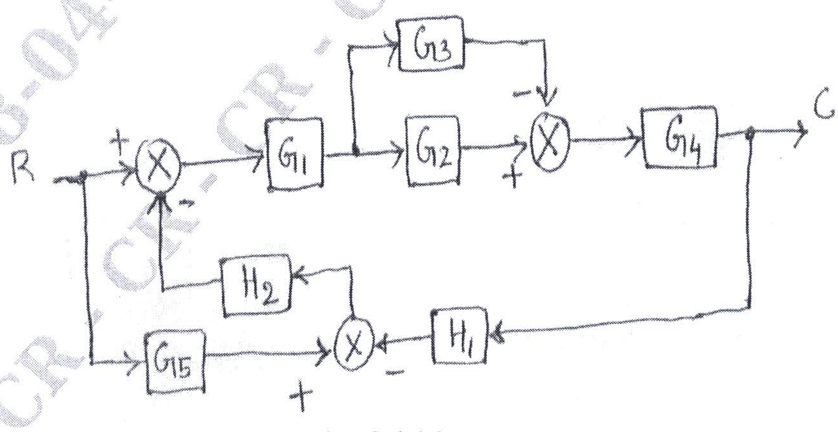

Fig. Q6 (c) **(08 Marks)**

Module-4

7 a. Derive time-domain expression for the unit step response of a second order under damped system subjected to a unit step input. **(08 Marks)**

b. A unity feedback system has an open-loop transfer function,

$$G(s)H(s) = \frac{K}{s(s+10)}$$

Find the value of K so that the system will have a damping ratio of 0.5. For thin value of K, find rise time, peak time, peak over shoot and settling time corresponding to unit step response of the system. **(06 Marks)**

c. Refer the characteristic equation, given below $s^4 + 25s^3 + 15s^2 + 20s + K = 0$, $K > 0$
Find the range of K for closed loop stability. Use RH criterion. **(06 Marks)**

OR

8 a. State and derive expression for t_p, M_P and t_r corresponding to unit step response of a second order under damped system. **(08 Marks)**

b. A unity feed back system has an open – loop transfer function,

$$G(s)H(s) = \frac{K(1-s)}{s(s^2+5s+9)}.$$

Find the range of K for closed loop stability. Use RH criterion. **(06 Marks)**

c. Measurements conducted on a closed loop system reveals the unit step response to be,
$C(t) = 1 + 0.2e^{-60t} - 1.2e^{-10t}$, $t \geq 0$.
(i) Obtain the closed loop transfer function of the system
(ii) Find natural frequency and damping ratio of the system. **(06 Marks)**

Module-5

9 a. Sketch the root-locus plot, if the open loop transfer function,

$$G(s)H(s) = \frac{K(s+6)}{s(s+1)(s+2)}.$$

Show all the salient points on the root locus. **(12 Marks)**

b. Compute the state transition matrix for the given system matrix,

$$A = \begin{bmatrix} 1 & 0 \\ 1 & 1 \end{bmatrix}$$ using Laplace approach. **(08 Marks)**

OR

10 a. Sketch the root-locus plot for a negative feedback system having an open-loop transfer function.

$$G(s)H(s) = \frac{K}{s(s+1)(s+2)}, \; K > 0$$ **(12 Marks)**

b. Obtain the state-transition matrix of the following system:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix}$$

Also, find the inverse of state-transition matrix. **(08 Marks)**

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