Bapatla Engg college : Bapatla.
Dept of EIE , 2/4 EIE RE

Sub code 18EI304   Sub: Network Theory
2/4 EIE, 3rd Sem   MaxMarks: 50.

1. Answer all questions

a) Energy is the capacity for doing work i.e energy is nothing but stored work.
Energy is measured in Joules(J)
Power is the rate of change of energy

$$\text{Power} = \frac{\text{Energy}}{\text{time}} = \frac{W}{t}.$$

Power is measured in watts. (W)

b) Independent sources for which voltage and current are independent and are not affected by other parts of the ckt
In case of dependent source the source voltage or current is not fixed, but is dependent on the voltage and current existing at some other location in the ckt.

c)
$$\text{crest factor} = \frac{\text{Peak value of wave}}{\text{RMS value of wave}} = \frac{V_p}{V_{rms}}$$

$$\text{Form factor} = \frac{\text{RMS value of wave}}{\text{Avg value of wave}} = \frac{V_{rms}}{V_{av}}$$

d) The phase of a sine wave is an angular measurement that specifies the position of the sine wave relation to a reference.
If we draw wave forms for both voltage and current at different positions we can observe the phase difference b/w two wave forms

e) In any linear N/w, if a single voltage V_a in branch 'a' produces a current I_b in branch b. then if the vol source V_a is removed and inserted in branch b will produce a current I_b in branch 'a'. The ratio of response to excitation is same for the two conditions mentioned above. This is called the reciprocity theorem.

f) In a series RLC ckt, series resonance occurs when $X_L = X_C$. The freq at which the resonance occurs is called resonant freq.

$$f_r = \frac{1}{2\pi\sqrt{LC}}$$

g) The response changes with time, gets saturated after some time and is referred to as the transient response.
A ckt having const sources is said to be in steady state if the currents and voltages do not change with time.

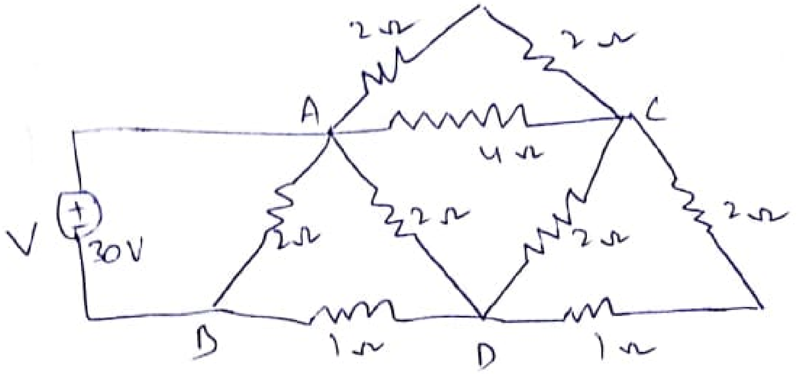
h) LT of Unit ramp function is $\frac{1}{s^2}$

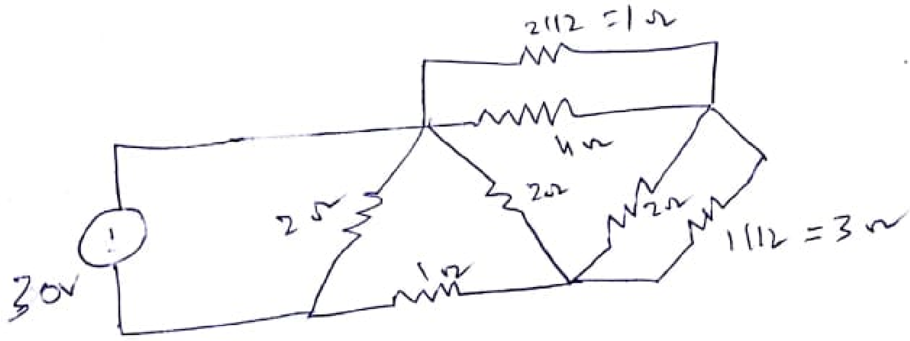
i) 1. Diff 2. Integration 3. Translation 4. scale change etc.

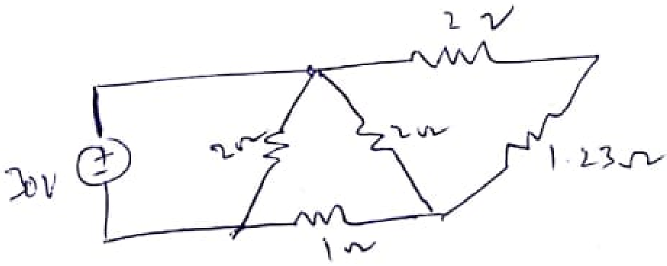
j) $Z_{11} = \frac{V_1}{I_1}\Big|_{I_2=0}$ $Z_{12} = \frac{V_1}{I_2}\Big|_{I_1=0}$ $Z_{21} = \frac{V_2}{I_1}\Big|_{I_2=0}$ $Z_{22} = \frac{V_2}{I_2}\Big|_{I_1=0}$

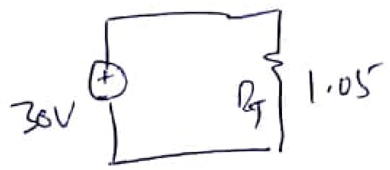
Unit - I

2 a) 5M





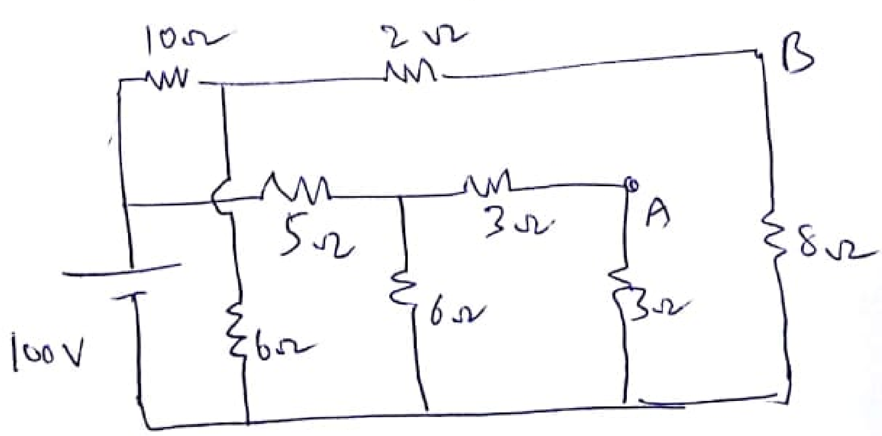


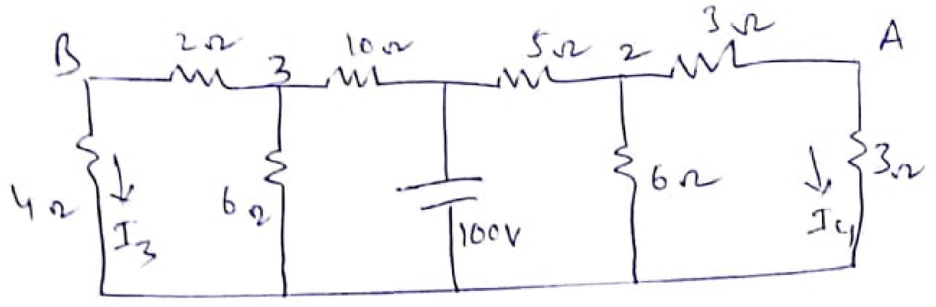


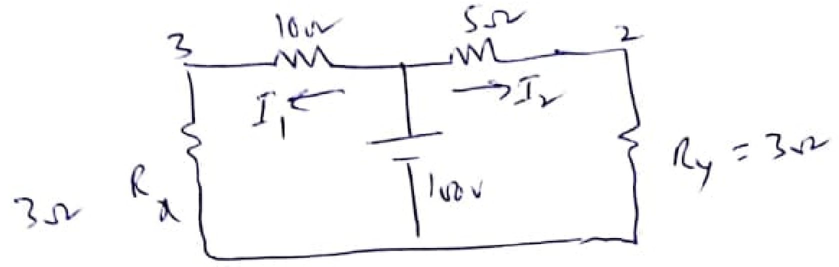
current delivered by the source

$$= \frac{30}{1.05} = 28.57A.$$

b)







$R_x = (2+4) \parallel 6 = 3Ω$ $\quad$ $R_y = (3+3) \parallel 6 = 3Ω$

$I_1 = \frac{100}{13} = 7.69A$ $\quad$ $I_2 = \frac{100}{8} = 12.5A.$

$I_3 = 7.69 \times \frac{6}{12} = 3.845A$

$I_4 = 12.5 \times \frac{6}{12} = 6.25A.$

$V_{AB} = V_A - V_B$

$V_A = I_3 \times 3 = 6.25 \times 3 = 18.75V$

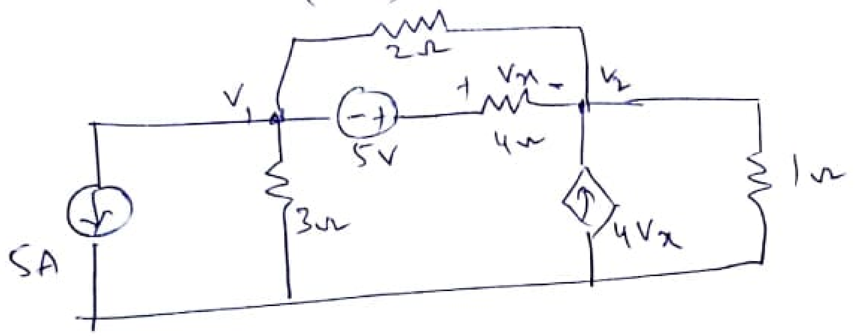
$V_B = I_4 \times 4 = 3.845 \times 4 = 15.38V$

$V_{AB} = 18.75 - 15.38 = 3.37V.$

5M

(OR)

3. a)



By applying KCL at node V_1

$$5 + \frac{V_1}{3} + \frac{V_1 - V_2}{2} + \frac{V_1 + 5 - V_2}{4} = 0 \quad -①$$ 1M

At node V_2

$$\frac{V_2 - 5 - V_1}{4} + \frac{V_2 - V_1}{2} - 4V_x + \frac{V_2}{1} = 0 \quad -②$$ 1M

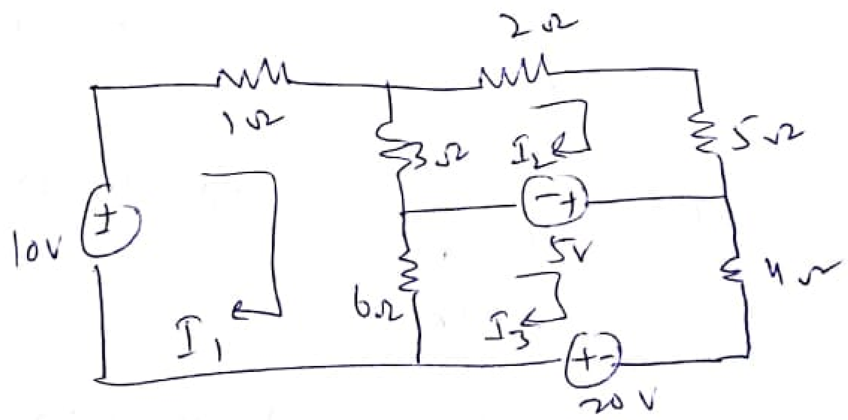
$$V_x = V_1 + 5 - V_2 \quad -③$$ 1M

By solving ①, ② and ③

$V_1 = -7.55V$ $\quad V_2 = -2.54$ 2M

$V_x = -0.01\,V.$

b)



$$-10 + I_1 + 3(I_1 - I_2) + 6(I_1 - I_3) = 0$$

$$10I_1 - 3I_2 - 6I_3 = 10V \quad -①$$

1M

$2I_2 + 5I_2 + 5 + 3(I_2 - I_1) = 0$

$-3I_1 + 10I_2 = -5\,V$ — (2) 1M

$-5 + 4I_3 - 20 + 6(I_3 - I_1) = 0$

$-6I_1 + 10I_3 = 25\,V$ — (3) 1M

$I_1 = 4.27\,A \quad I_2 = 0.78\,A \quad I_3 = 5.06\,A$ 1M

Voltage across 6Ω is $= \frac{I}{2} \times 6 = -3\,V$

1M

Unit - II

4 a)

Form factor $= \frac{V_{rms}}{V_{av}}$

Crest factor $= \frac{V_m}{V_{rms}}$

$V = V_m \sin \omega t \quad 0 < \omega t < \pi$ 1M

$= 0 \quad \pi < \omega t < 2\pi$

$V_{av} = \frac{1}{2\pi} \int_0^{\pi} V_m \sin \omega t \, d(\omega t)$ 2M

$= 0.318\,V_m$

$V_{rms} = \frac{V_m}{2}$ Form factor $= \frac{V_m/2}{0.318 V_m} = 1.572$

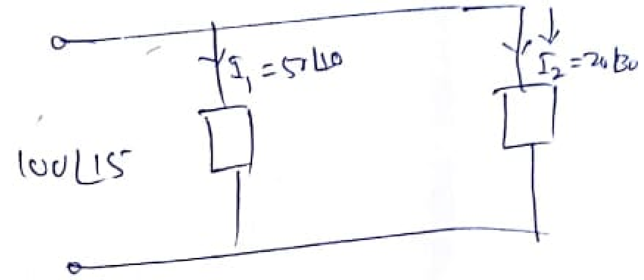
Crest factor $= \frac{V_m}{\cancel{0.318}\, V_m/2} = \cancel{3.14}\ 2$

2M

4.b) Average Power $= \frac{1}{t_2 - t_1} \int_{t_1}^{t_2} P(t)\, dt$

$P_{av} = V_{eff} I_{eff} \cos\theta$.

Reactive power $P_r = V_{eff} I_{eff} \sin\theta$ VAR



$$Z_1 = \frac{100\angle15}{50\angle10} = 1.99 + j0.174\ \Omega$$

$$Z_2 = \frac{100\angle15}{20\angle30} = 5\angle{-15} = 4.83 - j1.29\ \Omega$$

True power in Z_1 is $P_{t_1} = I_1^2 R = (50)^2 \times 1.99$
$= 4975$ W

Reactive power in Z_1 is $P_{r_1} = I_1^2 X_L$
$= (50)^2 \times 0.174 = 435$ VAR

Apparent power in Z_1 is $P_{a_1} = I_1^2 Z_1$
$= (50)^2 \times 2 = 5000$ VA.

True power in Z_2 is $P_{t_2} = I_2^2 R$
$= (20)^2 \times 4.83 = 1932$ W

Reactive power in Z_2 is $P_{r_2} = I^2 X_c$
$= (20)^2 \times 1.29 = 516$ VAR

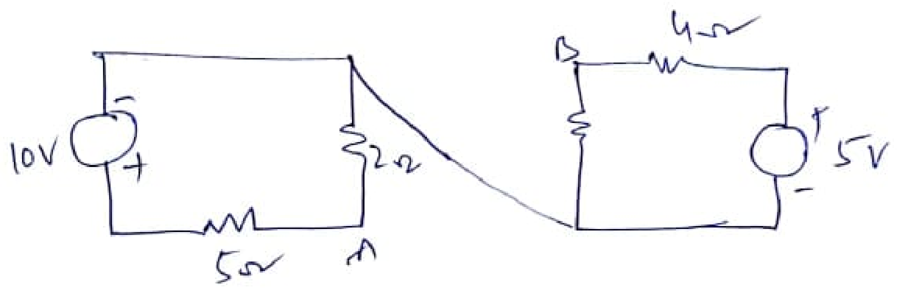
Apparent power in Z_2 is $P_a = I_2^2 Z_2$
$= (20)^2 \times 5 = 2000$ VA.

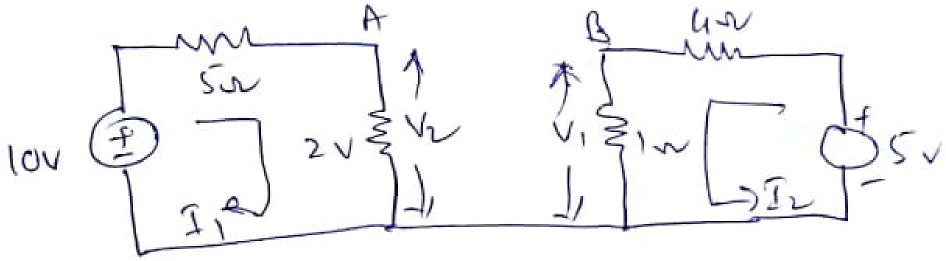
(OR)

5 a) Super position theorem statement — 2 M

Super position Theorem Proof with example — 3 M

b)





$V_{AB} = V_2 + V_1$ $\qquad$ $V_{AB} = V_2 - V_1$

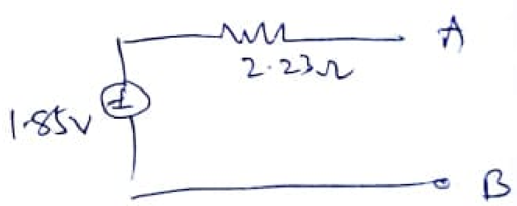
$V_2 = 2 \times \frac{10}{7} = 2.85$ $\qquad$ $= 2.85 - 1 = 1.85V$

$V_1 = 1 \times \frac{5}{5} = 1V$

Thevenin's Resistance b/w AB

$R_{AB} = (5 \| 2) + (4 \| 1) = 1.43 + 0.8 = 2.23\Omega$

Thevenin's equivalent ckt



Scanned by CamScanner

6 a) RLC series resonance ckt

Derivations

$$f_0 = \frac{1}{2\pi\sqrt{LC}}$$

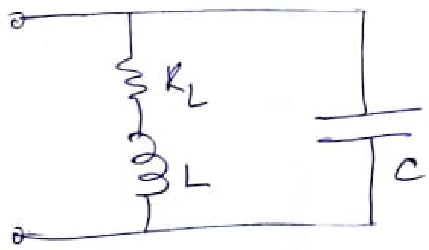
$$BW = \frac{R}{2\pi L}$$

$$f_1 = f_0 - \frac{R}{4\pi L}$$

$$f_2 = f_0 + \frac{R}{4\pi L}$$

$$Q = \frac{f_r}{f_2 - f_1}$$

6 b)



$L = 0.1\ H$

$Q = 5$

$W_0 = 50\ rad/sec$

$$Q = \frac{W_0 L}{R} = \frac{50 \times 0.1}{R}$$

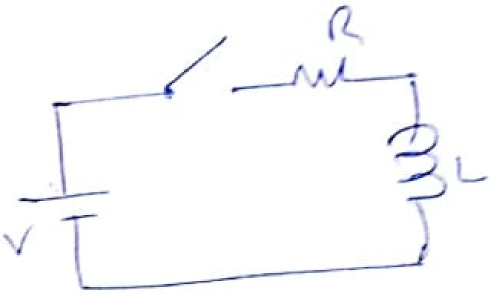
$$R = \frac{50 \times 0.1}{5} = 1\Omega$$

$$W_0^2 = \frac{1}{LC} \qquad (50)^2 = \frac{1}{(0.1) \times C}$$

$$C = \frac{1}{(0.1) \times (50)^2} = 40\ mF$$

7 a) DC response of RL & RC ckt

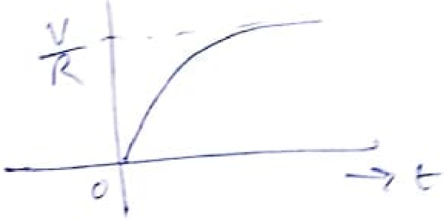
RL ckt



$$V = Ri + L\frac{di}{dt}$$

$$\frac{di}{dt} + \frac{R}{L}i = \frac{V}{L}$$

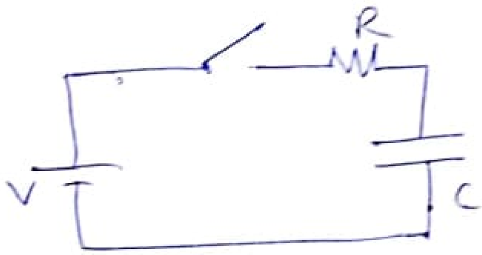
$$i = c\,e^{-(R/L)t} + \frac{V}{R}$$



$t=0 \quad i=0 \qquad c = \frac{V}{R}$

$$i = \frac{V}{R}\left(1 - e^{-\frac{R}{L}t}\right)$$

RC circuit



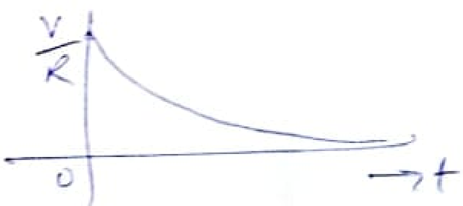
$$V = Ri + \frac{1}{C}\int i\,dt.$$

$$\frac{di}{dt} + \frac{i}{RC} = 0.$$

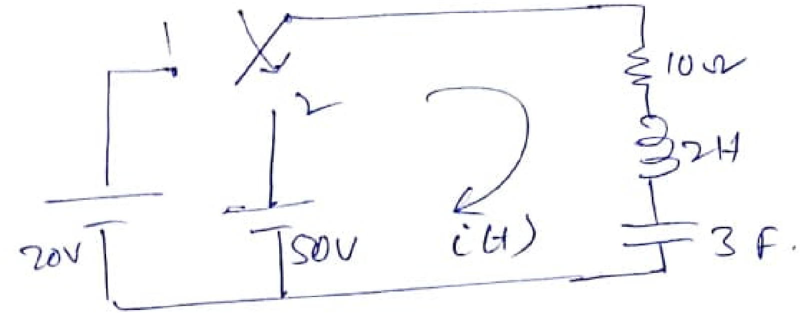
$$i = c\,e^{-t/RC}$$

$t=0 \quad i = \frac{V}{R} \qquad c = \frac{V}{R}$

$$i = \frac{V}{R}e^{-t/RC}.$$



7. b)



$$50 = 10i + 2\frac{di}{dt} + \frac{1}{3}\int i\,dt$$

$$\frac{d^2 i}{dt^2} + 5\frac{di}{dt} + \frac{i}{6} = 0.$$

$$D_1, D_2 = \frac{-5}{2} \pm \sqrt{\left(\frac{5}{2}\right)^2 - \frac{1}{6}}$$

$$= -2.5 \pm 2.47. = -0.03 ; -4.97$$

Solution $i = C_1 e^{-0.03t} + C_2 e^{-4.97t}$

$t=0 \quad i=0 \qquad C_1 + C_2 = 0$

$t=0 \qquad L\frac{di}{dt} = 50 \qquad \frac{di}{dt} = 25.$

$$\frac{di}{dt} = -0.03\, C_1\, e^{-0.03t} - 4.97 C_2\, e^{-4.97t}$$

$$25 = -0.03 C_1 - 4.97 C_2$$

$C_1 = 5.06 \qquad C_2 = -5.06$

$$i(t) = 5.06\, e^{-0.03t} - 5.06\, e^{-4.97t}$$

Unit IV

8. a) Initial value theorem

statement

$$\lim_{t \to 0} f(t) = \lim_{s \to \infty} sF(s) \quad -1M$$

Initial value theorem
Proof — $1\frac{1}{2}$M

Final value theorem
statement — 1M

$$\underset{t\to\infty}{Lt}\ f(t) = \underset{s\to 0}{Lt}\ sF(s)$$

Final value theorem
Proof. — $1\frac{1}{2}$M

8 b) Laplace Transform

i) $f(t) = (t+2)^2 e^t$

$$L\{f(t)\} = L[(t^2+4+2t)e^t]$$

$$= L\{t^2e^t + 4e^t + 2te^t\}$$

$$= \frac{2}{(S-1)^3} + \frac{4}{S-1} + \frac{2}{(S-1)^2}$$

ii) $f(t) = \dfrac{(2 - 2e^{-2t})}{t}$

let $f_1(t) = 2 - 2e^{-2t}$

$$L\{f_1(t)\} = \frac{2}{s} - \frac{2}{s+2} = \frac{4}{s(s+2)}$$

$$L\left[\frac{2-2e^{-2t}}{t}\right] = \int_0^\infty F_1(s)\,ds = \int_0^\infty \frac{4}{s(s+2)}\,ds$$

$$\frac{4}{s(s+2)} = \frac{A}{s} + \frac{B}{s+2} = \frac{2}{s} - \frac{2}{s+2}$$

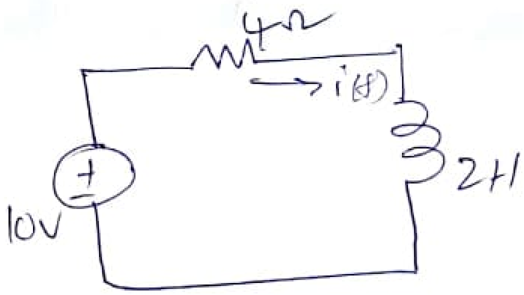
$$L\left[\frac{2-e^{-2t}}{t}\right] = \int_s^\infty L\left[2 - 2e^{-2t}\right] ds.$$

$$= \int_s^\infty \frac{2}{s}\, ds - \int_s^\infty \frac{2}{s+2}\, ds.$$

$$= -2\log\left[\frac{s}{s+2}\right]$$

$$L\left[\frac{2-2e^{-2t}}{t}\right] = 2\log\left(\frac{s+2}{s}\right).$$

9. a)



$$10 = 4i + 2\frac{di}{dt}$$

$$2\frac{di}{dt} + 4i = 10$$

$$\cancel{2sI + 4I = \frac{10}{s}} \qquad 2\left[sI + 1\right] + 4I = \frac{10}{s}$$

$$\frac{10}{s} - 4I - 2sI + 2 = 0$$

$$10 - 4sI - 2s^2 I + 2s = 0$$

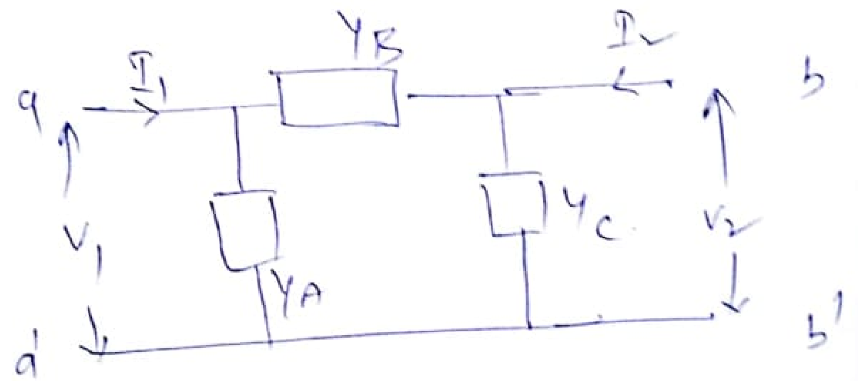
$$I = \frac{10+2s}{2s(s+2)}$$

$$I = \frac{K_1}{s} + \frac{K_2}{s+2} \qquad K_1 = \frac{5}{2} \quad K_2 = -\frac{3}{2}$$

$$I = \frac{5/2}{s} + \frac{-3/2}{s+2}$$

$$i(t) = \frac{5}{2} - \frac{3}{2}e^{-2t}.$$

9. b)



Y Parameters

$$Y_{11} = \left.\frac{I_1}{V_1}\right|_{V_2=0} = Y_A + Y_B$$

$$Y_{21} = \left.\frac{I_2}{V_1}\right|_{V_2=0} = -Y_B$$

$$Y_{22} = \left.\frac{I_2}{V_2}\right|_{V_1=0} = Y_B + Y_C$$

$$Y_{12} = \left.\frac{I_1}{V_2}\right|_{V_1=0} = -Y_B$$

$$I_1 = (Y_A + Y_B) V_1 - Y_B V_2$$

$$I_2 = -Y_B Y_1 + (Y_C + Y_B) V_2 .$$

— $2\frac{1}{2}$ M

Z Parameters

$$Z_{11} = \frac{Y_{22}}{\Delta Y}$$

$$Z_{12} = \frac{-Y_{12}}{\Delta Y}$$

$$Z_{21} = -\frac{Y_{21}}{\Delta Y}$$

$$Z_{22} = \frac{Y_{11}}{\Delta Y}.$$

$$Y_{11} = Y_A + Y_B$$

$$Y_{12} = -Y_B$$

$$Y_{21} = -Y_B$$

$$Y_{22} = Y_B + Y_C$$

$$\Delta Y = Y_{11}Y_{22} - Y_{21}Y_{22}$$

— $2\frac{1}{2}$ M