20 marks) Q(1):

(a) **(10 marks)** For the circuit shown in Fig.1.a, find the equivalent capacitance between terminals **a** and **b**.

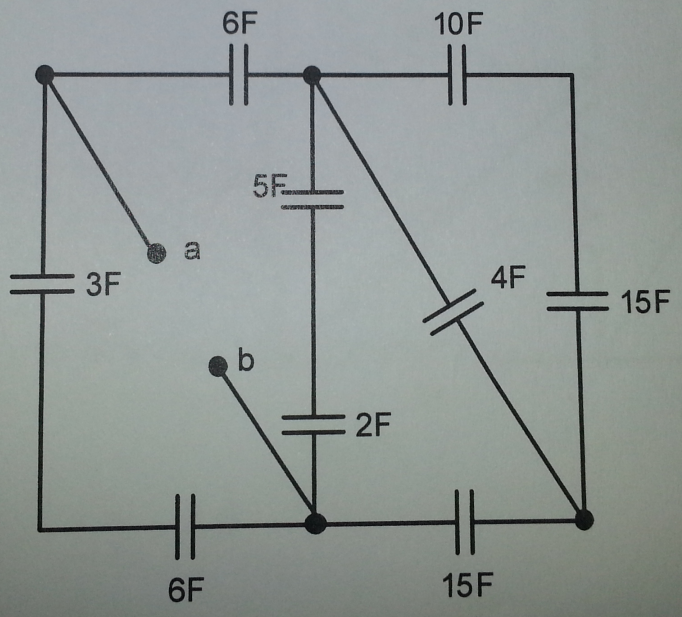


Fig. 1.a

10, 15 are in series.

Second exam

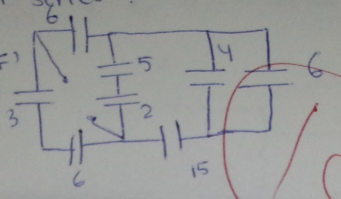
Fig. 1.a

Second exam
Summer course
2014 - 2015

Q1) Part a.

10, 15 are in series.

$\frac{10 \times 15}{10+15} = 6$ (F)

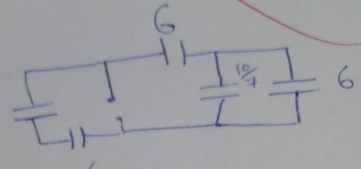


4, 6 are in parallel

4 + 6 = 10 (F)

10, 15 in series

$\frac{10 \times 15}{10+15} = 6$ (F)



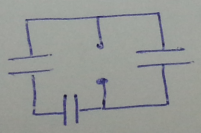
5, 2 are in series.

$\frac{5 \times 2}{7} = \frac{10}{7}$ (F)

$\frac{10}{7}$, 6 are in parallel

$\frac{10}{7} + 6 = \frac{52}{7}$ (F)

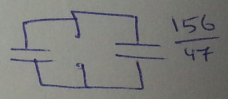
$\frac{52}{7}$, 6 are in series



$\frac{\frac{52}{7} \times 6}{\frac{52}{7} + 6} = \frac{156}{47}$ (F)

3, 6 are in series

$\frac{3 \times 6}{3+6} = 2$ (F)



2, $\frac{156}{47}$ are in parallel

$2 + \frac{156}{47} = \frac{250}{47}$ (F)

$= 5.319$ (F)

(10 marks) For the circuit shown in Fig.1.b, find the equivalent inductance between terminals **a** and **b**.

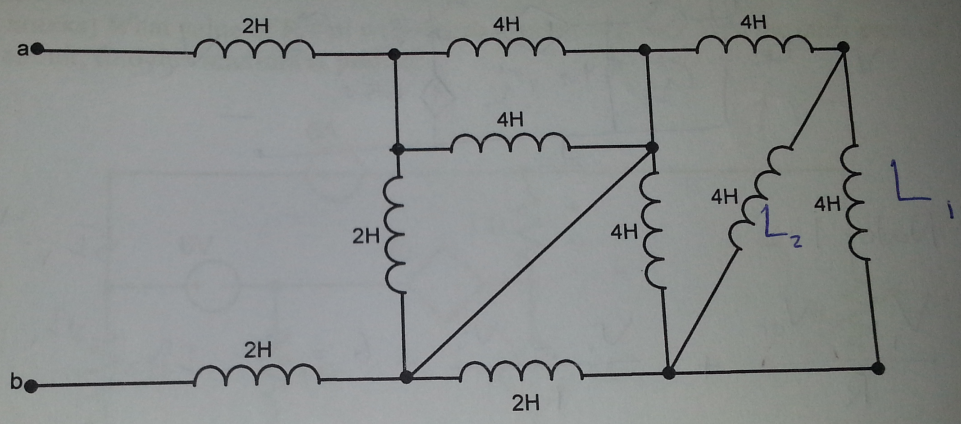


Fig.1.b

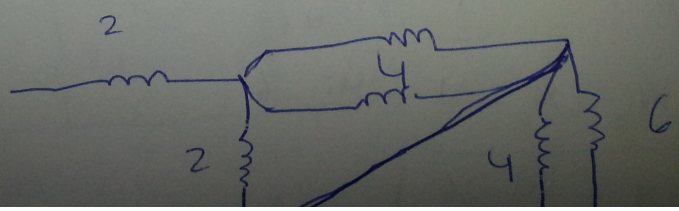
In the right :-

有 L_1 & L_2 are in parallel.

$L_{eq} = 2\,H$

L_{eq} is in series with the 4 H inductor at the top.

$4 + 2 = 6\,H$.



Q1) Part b

Summer 2014 - 2015

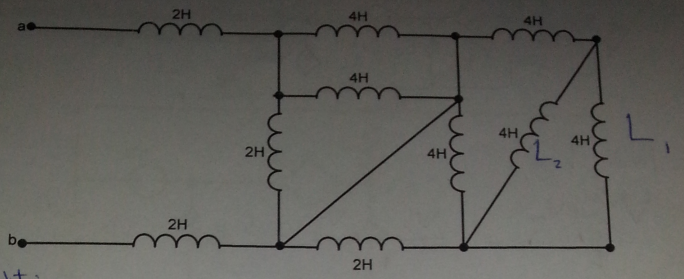


Fig.1.b

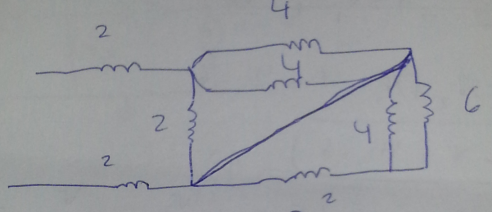
In the right :-

L_1 & L_2 are in parallel.

$L_{eq} = 2\ H$

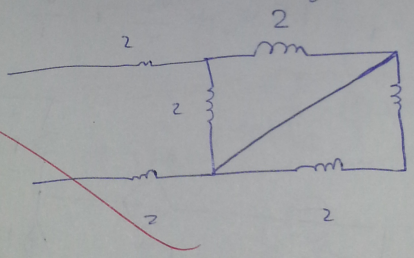
L_{eq} is in series with the 4 H inductor at the top.

$4 + 2 = 6\ H$.



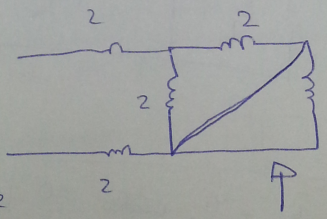
$4 \| 4 = 2\ H$

$6 \| 4 = 2.4\ H$



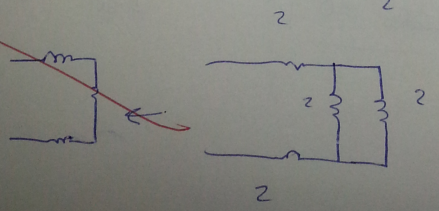
$2.4 + 2 = 4.4\ H$

$2 \| 2 = 1\ H$



All are in series

$2 + 2 + 1 = 5\ H$



4.4 is ~~cancelled~~ cancelled where it's connected into short ckt.

Q1) Part b

Exam

Second Summer Course 2014 - 2015

(25 marks) Q(2): For the circuit shown in Fig. 2.

(a) **(15 marks)** Find the Thévenin equivalent circuit for the circuit seen by the variable resistor **R**.

(b) **(10 marks)** What value of **R** that will absorb maximum power from the other parts of the circuit, find this **maximum power**?

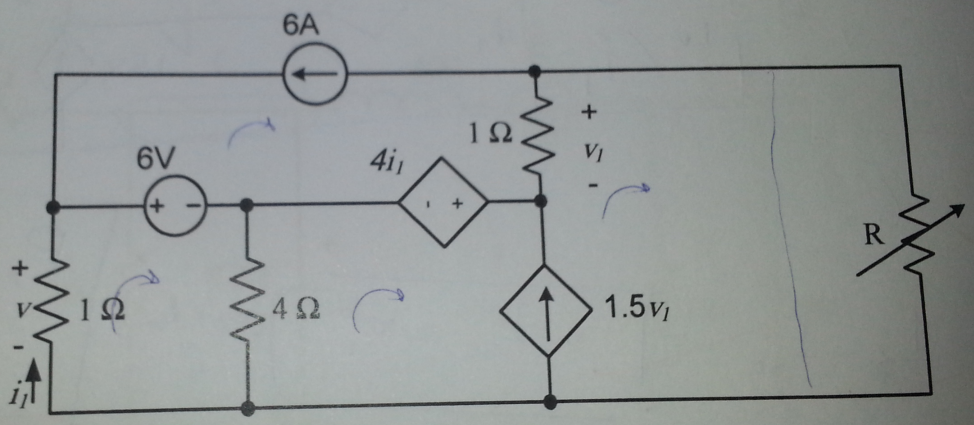
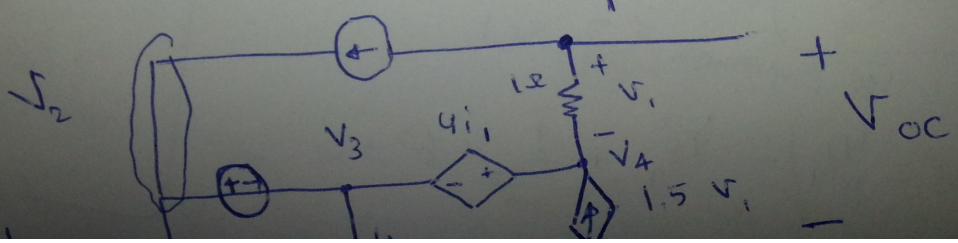
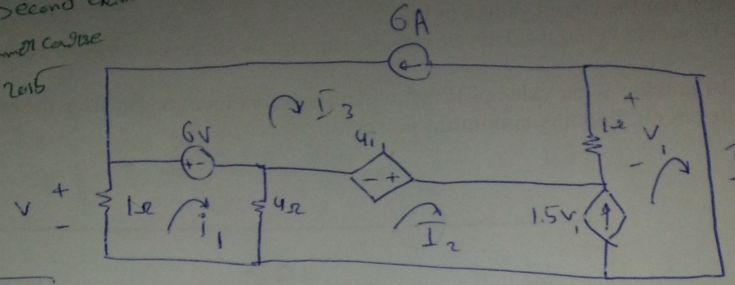


Fig. 2

Open CKT 3-



Q2 Second exam
Summer course
2014 - 2015



Mesh 3

$I_3 = -6$

$V_1 = I_3 - I_{sc} = -6 - I_{sc} = V_1$ Ohm's law

Mesh 1

$5i_1 - 4I_2 = -6$

@ Supermesh (2, sc)

$4I_2 - 4i_1 - 4i_1 + I_{sc} + 6 = 0$

$I_{sc} - I_2 = 1.5 V_1$

$I_{sc} - I_2 = -1.5(6 + I_{sc})$

$I_{sc} + 1.5 I_{sc} - I_2 = -9$

$2.5 I_{sc} - I_2 = -9$

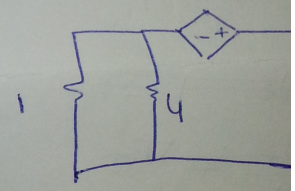
$I_{sc} = -1.5 V_1 + 4i_1 + i_1$

$= -1.5(-6 - I_s) + 5i_1 =$

I_{sc}

$P_m = \frac{(1.65)}{4(\frac{4}{9}}$

$= 1.533$



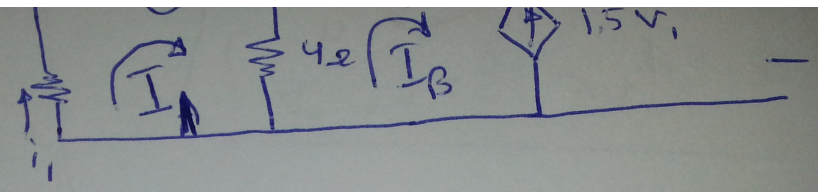
$1 // 4 = \frac{4}{5}$

$\frac{4}{5} // 1$

$\frac{\frac{4}{5}}{\frac{4}{5} + \frac{5}{5}} = \frac{4}{9} = R$

$V = I_{sc} R_{th}$

$+6=0$



$4i_1$

The max. power is when $R = R_{th}$.

~~and~~ ~~is~~ ~~8~~ $P_{Max} = \frac{V_{th}^2}{4R_{th}}$

8.5

(30 marks) Q(3): For the circuit shown in Fig. 3.

1. **(8 marks)** Write the required Nodal equations.
2. **(7 marks)** Draw the dual circuit, show the numerical values of the different elements.
3. **(15 marks)** If the circuit is in steady-state where $v(t) = 5V$ and $i(t) = 2A$, then find V_c, i_L, and i_x.

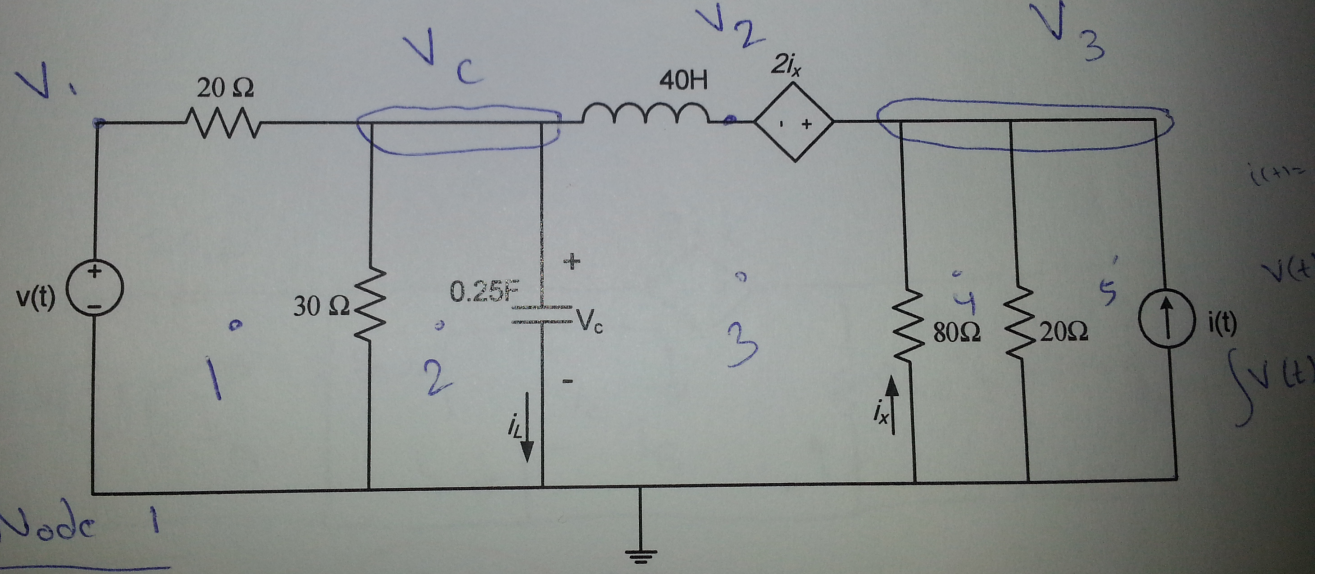


Fig. 3

Fig. 3

@ Node 1

$V_1 = v(t)$

@ Node C :-

$$\frac{V_c - v(t)}{20} + \frac{V_c}{30} + 0.25\,\frac{dv_c(t)}{dt} + \frac{\int V_c - V_2\,dt + i_L(t_0)}{L} = 0$$

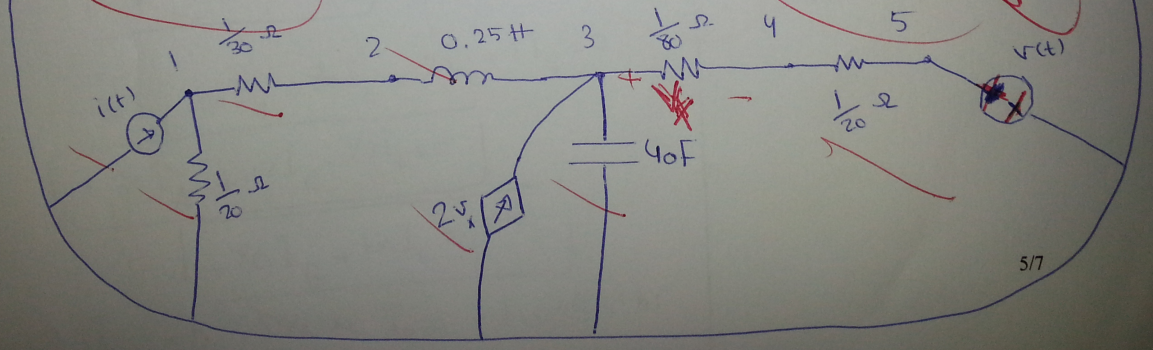
@ ~~Supernode (C-2)~~

@ Supernode (2,3)

$$\frac{1}{L}\int V_2 - V_c\,dt = i(t_0) + (-i_x) + \frac{V_3}{20} = i(t)$$

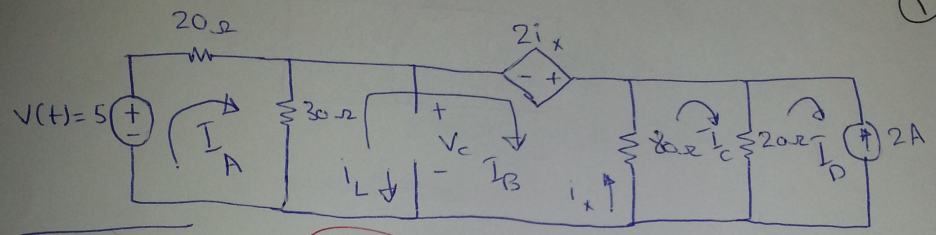
$$\frac{V_c - v(t)}{20} + \frac{V_c}{30} + i_L + \frac{1}{L}\int V_c - V_2\,dt + i(t_0) = 0$$

$V_3 - V_2 = 2i_x$



③ In steady state :-

Every capacitor is represented by an open CKT.
and every inductor is represented by short CKT.



① ②

i_L = Zero where it's open CKT. ⑤

@ Mesh A :-

$$-5 + 50\bar{I}_A - 30\bar{I}_B = 0$$

@ Mesh B :-

$$-30\bar{I}_A + 110\bar{I}_B - 80\bar{I}_C = 2i_x$$

@ Mesh C :-

$$-80\bar{I}_B + 100\bar{I}_C - 20\bar{I}_D = 0$$

D :- $\bar{I}_D = -2\ A$

$$i_x = \bar{I}_C - \bar{I}_B$$

$$-30\bar{I}_A + 110\bar{I}_B - 80\bar{I}_C - 2\bar{I}_C + 2\bar{I}_B = 0$$

$$-30\bar{I}_A + 112\bar{I}_B - 82\bar{I}_C = 0$$

$$V_C = (\bar{I}_A - \bar{I}_B)(30)$$

$$= (-0.5296 + 1.0493)(30$$

V_c = 15.291 (volts) ⑤

② 2

$$i_x = \bar{I}_C - \bar{I}_B$$

$$i_x = -1.239 + 1.0493$$

i_x = -0.1897 (A) ⑤

$$-5 + 50\bar{I}_A - 30\bar{I}_B = 0$$

@ Mesh B :-

$$-30\bar{I}_A + 110\bar{I}_B - 80\bar{I}_C = 2i_x$$

@ Mesh C :-

$$-80\bar{I}_B + 100\bar{I}_C - 20\bar{I}_D = 0$$

@ Mesh D :- $\bar{I}_D = -2\,A$

$$i_x = \bar{I}_C - \bar{I}_B$$

$$-30\bar{I}_A + 110\bar{I}_B - 80\bar{I}_C - 2\bar{I}_C + 2\bar{I}_B = 0$$

$$-30\bar{I}_A + 112\bar{I}_B - 82\bar{I}_C = 0$$

$$-80\bar{I}_B + 100\bar{I}_C = -40$$

$\bar{I}_A = -0.5296\,(A)$ $\bar{I}_B = -1.0493\,(A)$

$\bar{I}_C = -1.239\,(A)$

$$V_C = (\bar{I}_A - \bar{I}_B)(30)$$

$$= (-0.5296 + 1.0493)(30)$$

$$V_C = 15.291 \text{ (volts)}$$

(5) (2)

$$i_x = \bar{I}_C - \bar{I}_B$$

$$i_x = -1.239 + 1.0493$$

$$i_x = -0.1897\,(A)$$

(5)

(25 marks) Q(4): The variable dc voltage source V_s in the circuit shown in Fig.4 is adjusted so that i is zero, find the value of V_s.

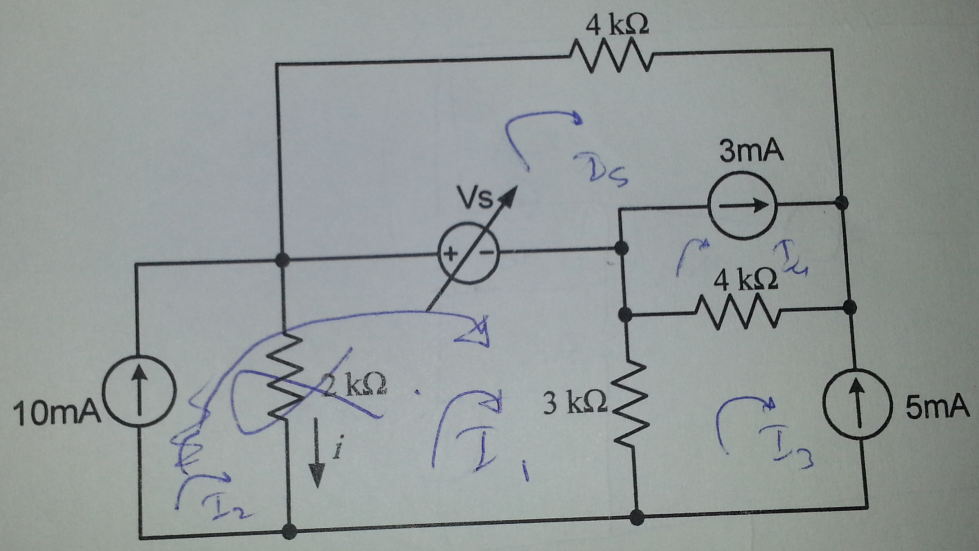


Fig. 4

when $i = 0$, then the CKT will be.

4 kΩ

Vs 3mA

Applying superposition

Mesh 2:-

~~Super Mesh (3-4)~~

$$4(10)^3 I_3 - 4(10)^3(5)(10)^{-3} - V_s + 4(10)$$

$$I_3 \quad I_4 = 3\,mA$$

Applying superposition:- killing all the ~~current~~ voltage sources.