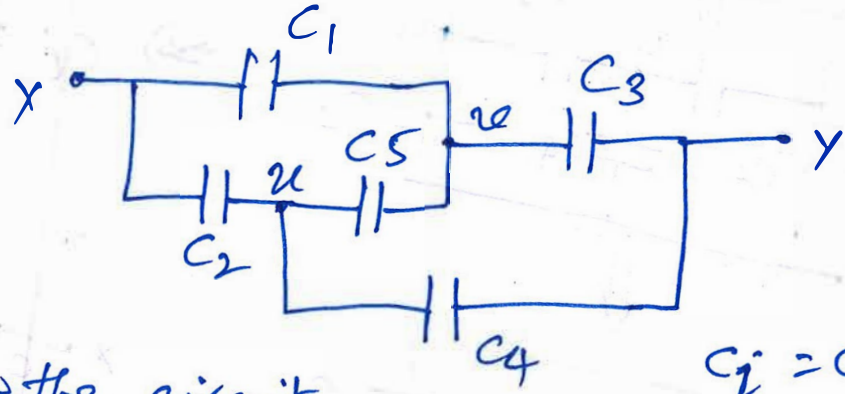


1)

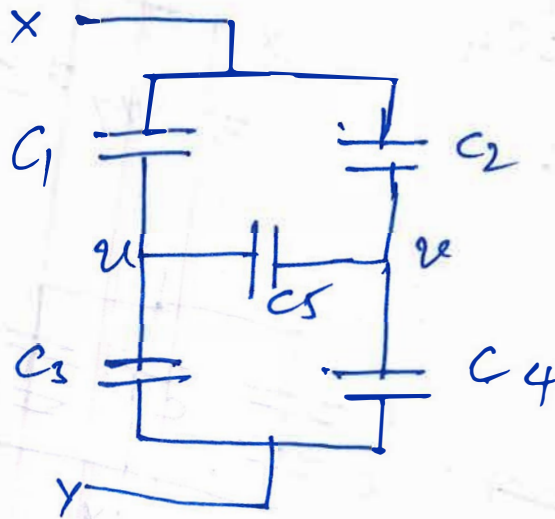
Fig. 4

①



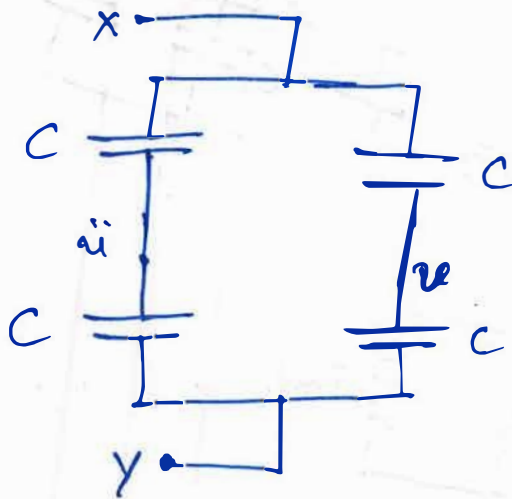
Re draw the circuit

$$C_i = C$$



$$\therefore C_i = C,$$

Capacitor between u and v acts like a open. Thus, re-draws the circuit,

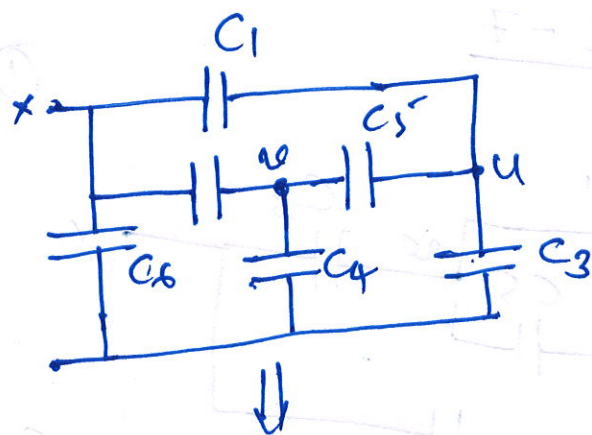


$$\Rightarrow C_{xy} = C$$

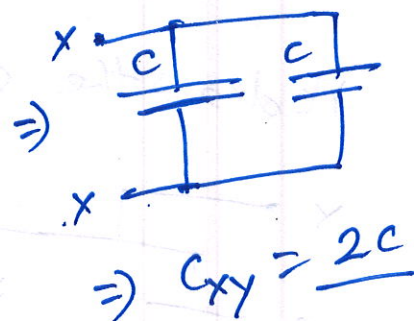
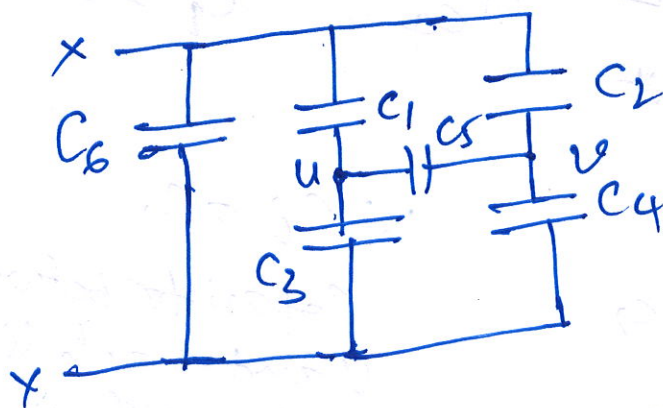
Note: Fig. 6 is similar except one more capacitor in parallel



2

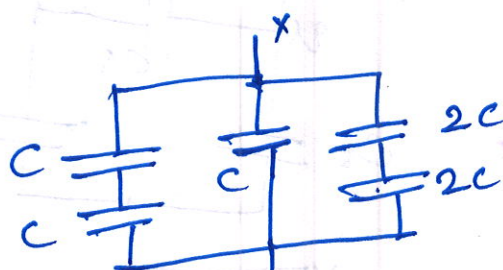
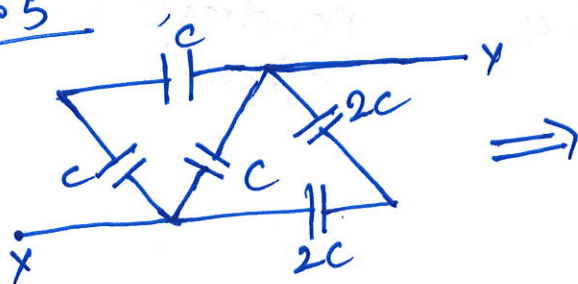


$$\Rightarrow C_i = C$$

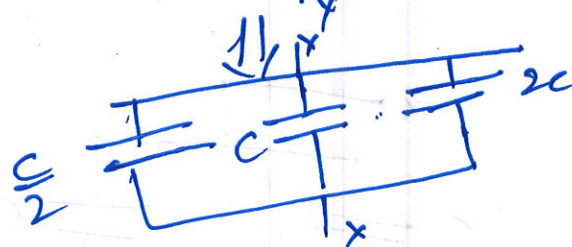


$$\Rightarrow C_{xy} = \frac{2C}{1}$$

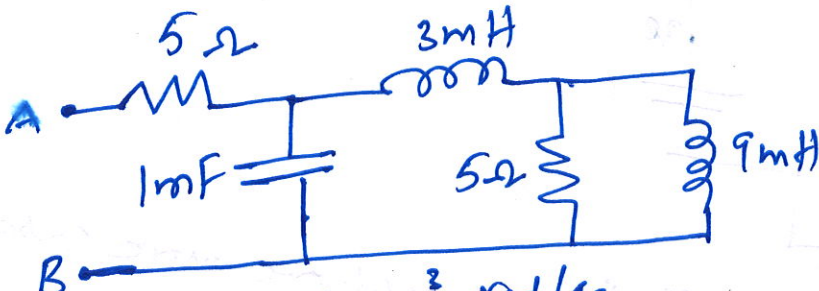
Fig 5



$$C_{eq} = 2.5C$$



3



$$\omega = 2.5 \times 10^3 \text{ rad/sec.}$$

$$X_{1mF} = -\frac{j}{\omega C} = -j0.4 \Omega$$

$$X_{3mH} = j\omega L = j7.5 \Omega$$

$$X_{9mH} = j\omega L = j22.5 \Omega$$

$$5 \parallel X_{9mH} = \frac{5 \times j22.5}{5 + j22.5} = \frac{112.5j (5 - j22.5)}{(5 + j22.5)(5 - j22.5)} \quad (3)$$

$$= \frac{562.5j + 2531.25}{(5)^2 + (22.5)^2} = 4.76 + j1.05j$$

$$(5 \parallel X_{9mH}) + X_{3mH} = 4.76 + j1.05j + j7.5$$

$$= 4.76 + j8.55$$

$$X_{1mF} \parallel [(5 \parallel X_{9mH}) + X_{3mH}] =$$

$$= \frac{(4.76 + j8.55)(-j0.4)}{(4.76 + j8.55 - j0.4)}$$

$$= \frac{3.42 - j1.904}{(4.76 + j8.15)}$$

writing in $|z| \angle \theta$ or $r \angle \theta$ form,

$$3.42 - j1.904 = 3.91 \angle -29.1^\circ$$

$$4.76 + j8.15 = 9.438 \angle 59.71^\circ$$

$\theta = \tan^{-1}(b/a)$
 $r = \sqrt{a^2 + b^2}$

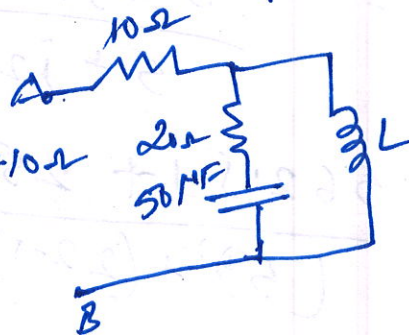
$$X = \frac{3.91 \angle -29.1^\circ}{9.438 \angle 59.71^\circ} = 0.414 \angle -88.1^\circ$$

$$= -0.414 + j0.04j$$

$$Z = 5\Omega + X = 4.586 + j0.014$$

4) Given $Z_{AB} = 25 + j10 \Omega$ $\omega = 4 \times 10^3 \text{ rad/sec}$ (4)

$$Z_{AB} = \left[j\omega L \parallel \left(20 - \frac{j}{\omega C} \right) \right] + 10 \Omega$$



$$25 + j10 = 10 + j\omega L$$

$$20 - \frac{j}{\omega C} = 20 - j5$$

$$j\omega L \parallel (20 - j5) = \frac{j\omega L (20 - j5)}{(20 - j5 + j\omega L)}$$

$$25 + j10 - 10 = \frac{j20\omega L + 5\omega L}{(20 + j(\omega L - 5))}$$

$$(15 + j10)[20 + j(\omega L - 5)] = 5\omega L + j20\omega L$$

Equating real parts

$$300 - 10\omega L + 50 = 5\omega L \Rightarrow L = \underline{5.83 \text{ mH}}$$

Equating imaginary parts,

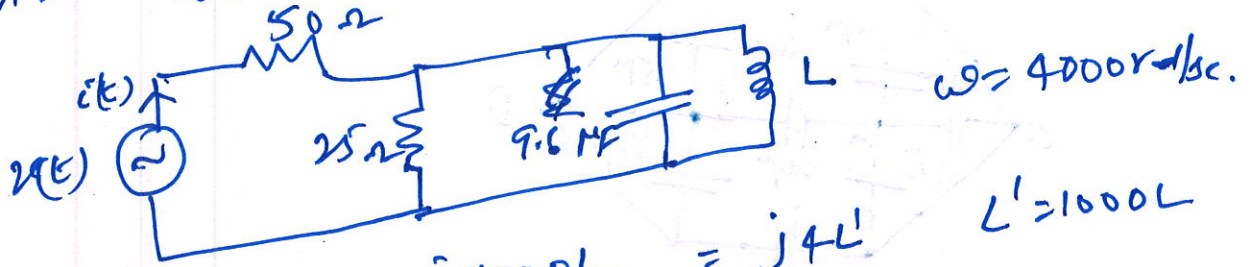
$$200j - 75j + j15\omega L = 20\omega L$$

$$125 = 5\omega L \Rightarrow L = \underline{6.25 \text{ mH}}$$

So two inductance values are possible.

⑥

5) Given that $v(t)$ and $i(t)$ are in phase



$$X_L = j\omega L = j4000L = j4L'$$

$$X_C = \frac{-j}{\omega C} = -26.04j$$

$$Z_{eq} = 50 + (X_L \parallel X_C \parallel 25)$$

for phase to be zero, imaginary part needs to be zero.

$$X_L \parallel X_C \parallel 25 = \frac{X_C \times X_L \times 25}{X_C X_L + X_C 25 + X_L 25}$$

$$\frac{2604 L'}{104.16 L' + j100 L' - 651j} + 50$$

$$= \frac{2604 L' (104.16 L' + j(100 L' - 651)) + 50}{(104.16 L')^2 + (100 L' - 651)^2}$$

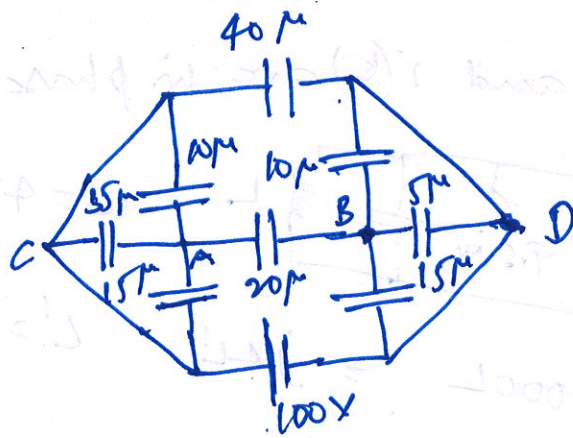
Equating imaginary part to zero,

$$104.16 L' \quad 100 L' - 651 = 0$$

$$L' = \frac{651}{100} = 6.51 \text{ mH}$$

$$L' = 1000 \therefore L = \underline{6.51 \text{ mH}}$$

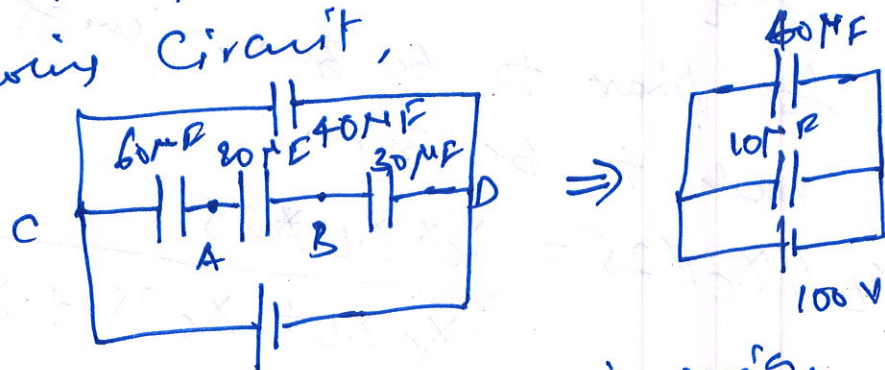
b)



$$10\mu \parallel 35\mu \parallel 15\mu = 60\mu F$$

$$5\mu \parallel 15\mu \parallel 10\mu = 30\mu F$$

re-drawing circuit,



As $60\mu F$, $20\mu F$, $30\mu F$ are in series,

$$C_{eq} = \left[\frac{1}{60} + \frac{1}{20} + \frac{1}{30} \right] = 10\mu F$$

$$10\mu F \parallel 40\mu F = 30\mu F$$

$$Q = C_{eq} V = 30 \times 10^{-6} \times 100 = 3000\mu C$$

Charge in $10\mu F$ capacitance is
 $100 \times 10\mu F = 1000\mu C$

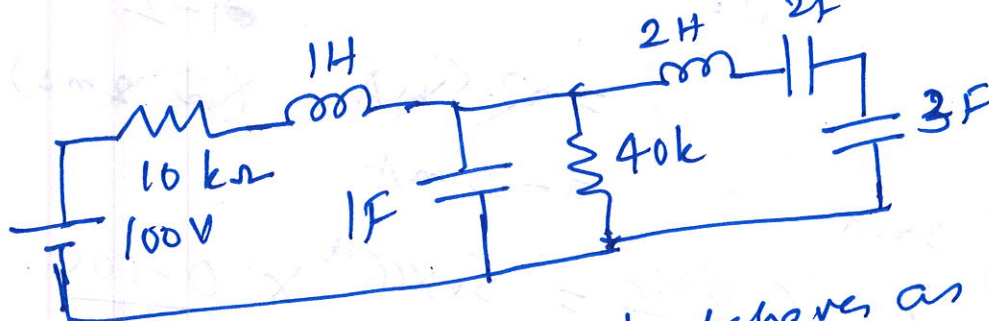
So charge on $20\mu F$ capacitance is
 $1000\mu C$

So voltage across $2\mu F$ capacitance is
 $V = \frac{Q}{C} = 50V$

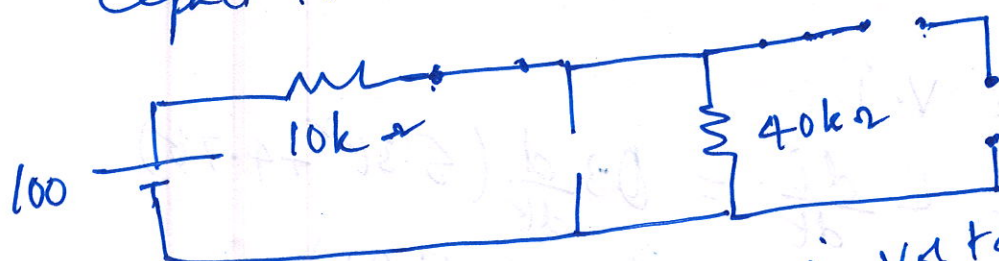
So energy stored is $\frac{1}{2} CV^2 = \frac{0.025 W}{2F}$

⑦

7)



In steady state, inductor behaves as a short, capacitor as an open. Redrawing the circuit



So voltage across 40k is voltage across 2F, 3F capacitors combined.

$$V_{40k} = \frac{100 \times 40}{10 + 40} = 80V$$

$$V_{2F} = \frac{80}{C_2} \left/ \left(\frac{1}{C_2} + \frac{1}{C_3} \right) \right. = \frac{80 \times 3}{5} = 48V$$

8)

$$V_L = L \frac{di}{dt} \quad L = 2mH \quad i(t) = \sin(377t)$$

$$\therefore V_L = 2 \times 10^{-3} \times 377 \cdot \cos(377t) \\ = 0.754 \cos(377t) V \quad \omega = 377 \frac{rad}{sec}$$

$$E_2 \quad \frac{1}{2} Li^2 = 10^{-3} \sin^2(377t)$$

$$9) \text{ 8) } i_c = C \frac{dv_c}{dt} = 50 \times 10^{-6} \times \frac{100-0}{0.1-2} \quad (8)$$

$$= -2.5 \text{ mA} \quad (\text{at } 2 \text{ ms})$$

$$= -5 \text{ mA}$$

at 3 ms

$$i_c = C \frac{dv_c}{dt} = 50 \times 10^{-6} \times \frac{0-100}{2-3}$$

$$= \underline{\underline{5 \text{ mA}}}$$

$$9) \text{ 10) } P = V \cdot I$$

$$V_L = L \frac{di}{dt} = 0.3 \frac{d}{dt} (5.3t^2 + 4.7t) \\ (3.18t + 1.41)$$

$$P = (5.3t^2 + 4.7t) (3.18t + 1.41)$$

$$= (16.854t^2 + 22.419t + 1.41) t$$

— 0 —