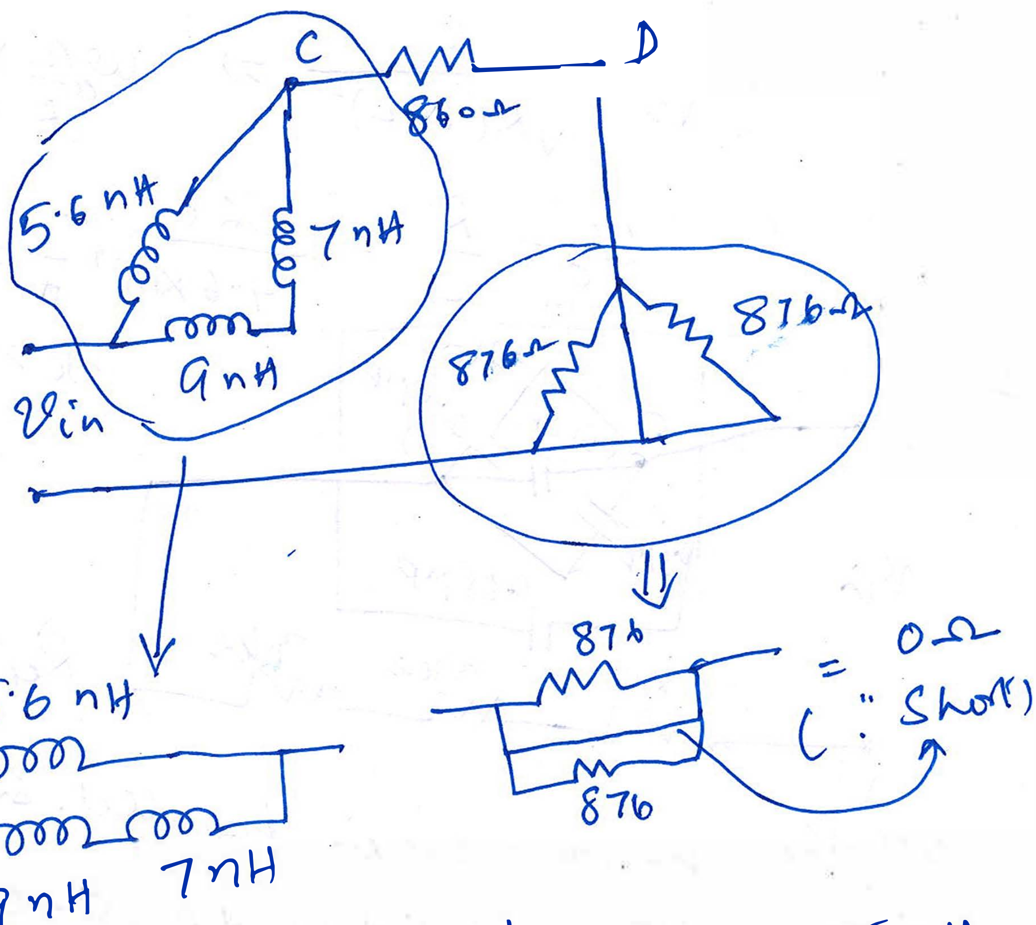
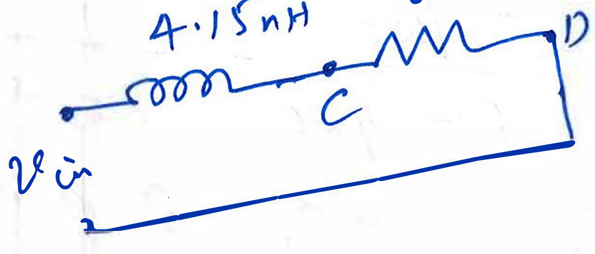
EECE105L Solutions to Tutorial Sheet-11

1)



$$\frac{1}{L_{eq}} = \frac{1}{(9n+7n)} + \frac{1}{(5\cdot 6n)} \Rightarrow L_{eq} = \underline{4.15\,nH}$$

Re-drawing the circuit



$$H(\omega) = \frac{V_R}{V_R + V_L}$$

$$= \frac{R}{R + j\omega L}$$

$$|H(\omega)| = \frac{R}{\sqrt{R^2 + \omega^2 L^2}} = \frac{1}{(1 + \omega^2 2.38 \times 10^{-23})^{1/2}}$$

at $\omega = 0$, $|H(\omega)| = 1$

at $\omega = \infty$ $|H(\omega)| = 0$

Thus a lowpass filter

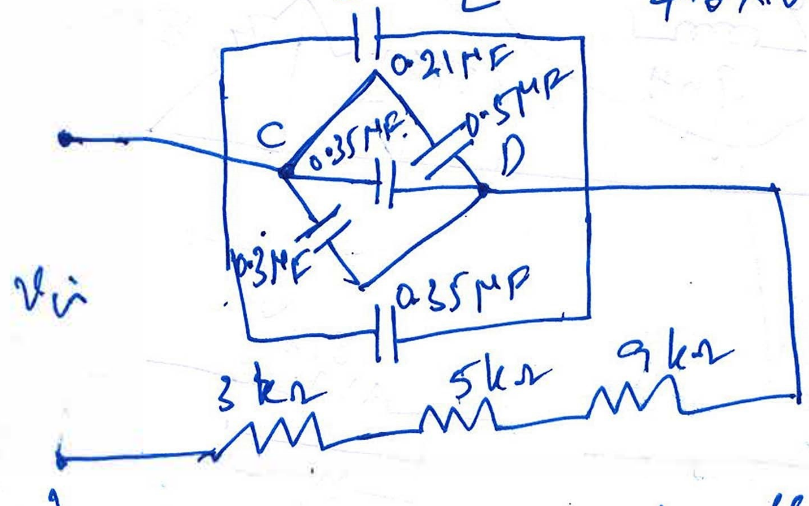
when $|H(\omega)| = \frac{1}{\sqrt{2}}$

$$\frac{1}{\sqrt{2}} = \frac{R}{\sqrt{R^2+(\omega L)^2}} \Rightarrow \omega_c\left(\frac{L}{R}\right) = 1$$

$$\omega_c = \frac{R}{L} = \frac{860}{4.6\times10^{-9}}\frac{\Omega}{H} = \underline{207.3\,GHz}$$

f_C=32.98 GHz

2)

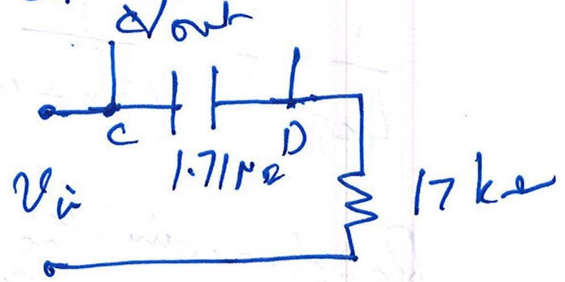


$$R_{eq} = (3+5+9)\,k\Omega = 17\,k\Omega$$

All the capacitors are in parallel. so

$$C_{eq} = (0.21+0.5+0.3+0.35+0.35)\,\mu F = 1.71\,\mu F$$

Re-drawing the circuit



$$H(\omega) = \frac{V_C}{V_R+V_C} = \frac{-j/\omega C}{R - j/\omega C} = \frac{1}{1+j\omega RC}$$

$$|H(\omega)| = \frac{1}{\sqrt{1+(\omega RC)^2}}$$

when $\cancel{R=0}$ $\omega=0$

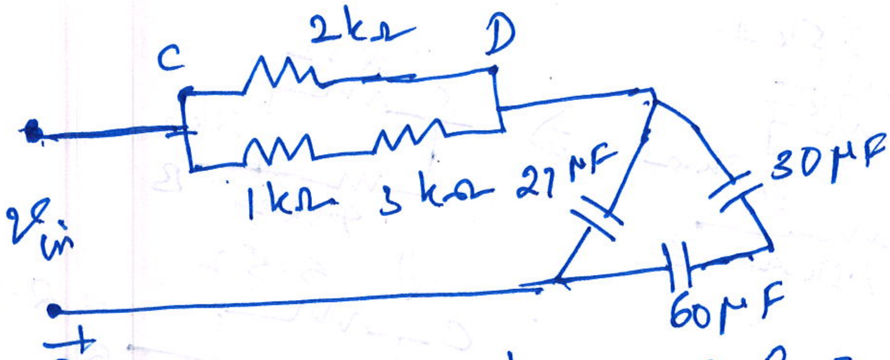
Low pass filter $\Leftarrow \begin{cases} |H(\omega)| = 1 \\ |H(\omega)| = 0 \text{ for } \omega=\infty \end{cases}$

$|H(\omega)| = \frac{1}{\sqrt{2}} \Rightarrow \omega_c RC = 1$ $f_c = \frac{1}{2\pi RC}$

$f_c = \underline{5.47\,Hz}$

$$|H(\omega)| = \frac{1}{\sqrt{1+(0.029)^2\omega^2}}$$

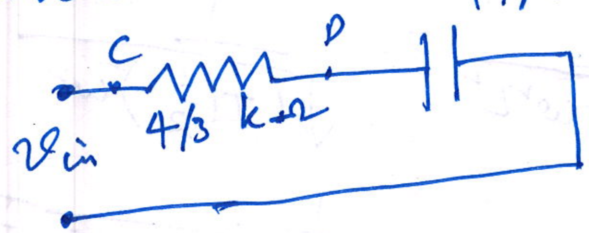
3



$$R_{eq} = \frac{1}{2k} + \frac{1}{(1k+3k)} \Rightarrow R_{eq} = \frac{4}{3}\,k\Omega$$

$$C_{eq} = 27\mu F + \frac{1}{\left(\frac{1}{60\mu} + \frac{1}{30\mu}\right)} = (27+20)\mu F = 47\mu F$$

Equivalent circuit : 47µF



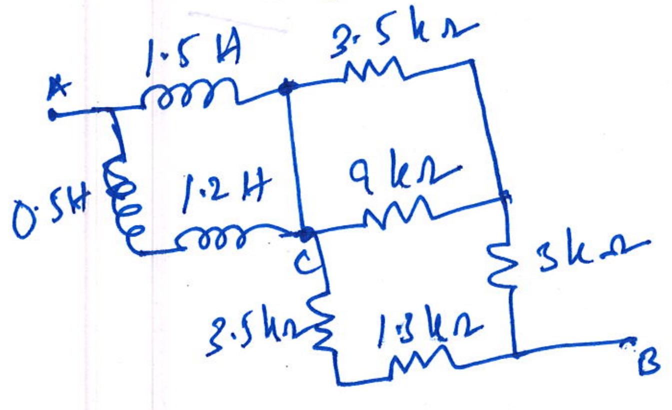
$$H(\omega) = \frac{V_R}{V_R + V_C}$$

$$|H(\omega)| = \frac{R}{\sqrt{R^2 + \frac{1}{\omega^2 C^2}}} = \frac{1}{\sqrt{1 + \frac{1}{(\omega RC)^2}}} = \frac{\omega RC}{\sqrt{1 + (\omega RC)^2}}$$

$$\left.\begin{array}{l} \omega \to 0 \Rightarrow H(\omega) \to 0 \\ \omega \to \infty \Rightarrow H(\omega) \to 1 \end{array}\right\} \to \text{High pass filter}$$

$$|H(\omega)| = \frac{0.063\omega}{\sqrt{1 + 4\times10^{-3}\omega^2}} \qquad f_c = \frac{1}{2\pi RC} = \underline{2.54\,Hz}$$

4

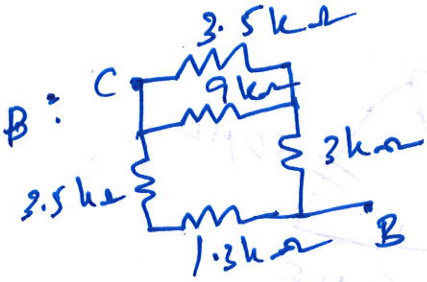


$$\frac{1}{L_{eq}} = \frac{1}{1.5} + \frac{1}{(1.2+0.5)}$$

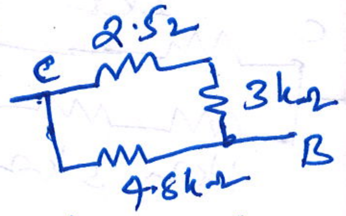
$$\Rightarrow L_{eq} \simeq 0.8\,H$$

④

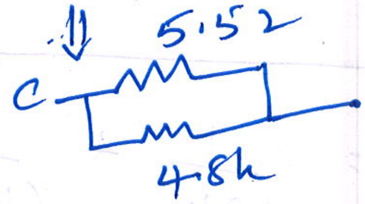
R_{CB} :



$\Rightarrow$

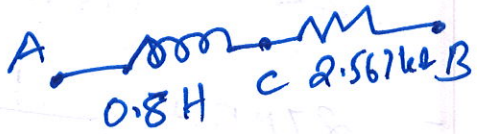


$\Downarrow$



$= 2.567 k\Omega$

Equivalent circuit:



$$H(\omega) = \frac{V_R}{V_L + V_C} = \frac{R}{j\omega L + R}$$

$$|H(\omega)| = \frac{R}{\sqrt{R^2 + \omega^2 L^2}} = \frac{1}{\sqrt{1 + \left(\frac{L}{R}\right)^2 \omega^2}}$$

$$= \frac{1}{\sqrt{1 + 0.097\omega^2 \times 10^{-6}}}$$

$$\left.\begin{array}{l} \omega \to 0 \quad |H(\omega)| \to 1 \\ \omega \to \infty \quad |H(\omega)| \to 0 \end{array}\right\} \Rightarrow \text{low pass filter}$$

f_c : $|H(\omega)| = \frac{1}{\sqrt{2}} \Rightarrow \frac{1}{2} = \frac{1}{1 + 0.097\omega^2 \times 10^{-6}}$

$\omega_c = \frac{1}{\sqrt{0.97}}$ $\quad f_c = \frac{1}{2\pi \times \sqrt{0.097 \times 10^{-6}}}$

$= \underline{510\ Hz}$