Lecture 3

*R-L-C Circuits :-

$$Z = \sqrt{R^2 + (|X_L - X_C|)^2} \quad , \tan\phi = \frac{X_L - X_C}{R} \text{ or } \frac{X_C - X_L}{R}$$

-Very Important :-

→ The following 3 impedances are Connected in series across 40V, 20 KHz :
1- Resistance of 8 ohm
2- Coil of Inductance L = 130 MH , R = 5 Ω
3- Resistance = 10 Ω , C = 0.25 MF

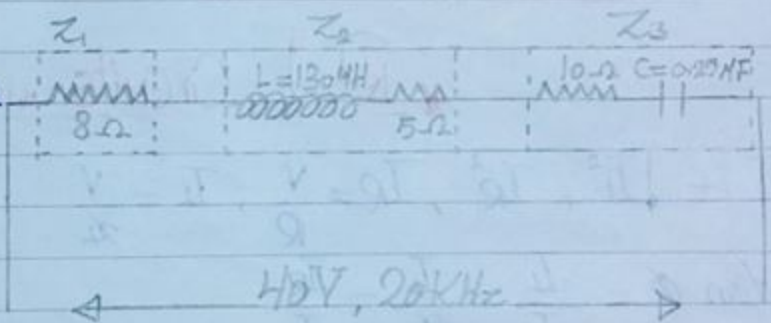
- Calculate :
1- The Circuit Current « I »
2- Phase Shift « angle ϕ »
3- The voltage load across each impedance

→ $X_L = 2\pi FL$

$= 2\pi \times 20\times10^3 \times 130\times10^{-6} = 16.34\ \Omega$

, $X_C = \frac{1}{2\pi FC} = \frac{1}{2\pi \times 20\times10^3 \times 0.25\times10^{-6}}$

$= 31.8\ \Omega$



, $Z = \sqrt{R^2 + (|X_L - X_C|)^2}$

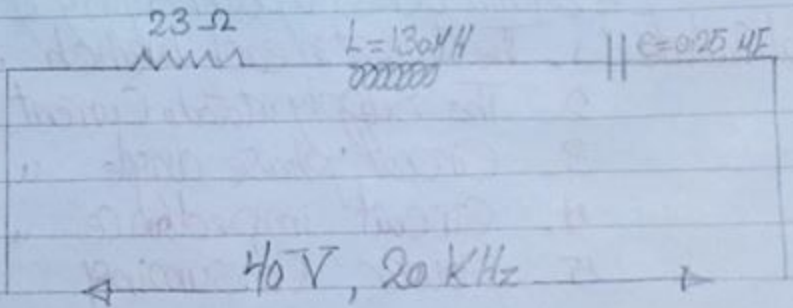
$= \sqrt{23^2 + (31.8 - 16.34)^2} = 27.7\ \Omega$

, $I = \frac{V}{Z} = \frac{40}{27.7} = 1.44\ A$ → (1)

, $\tan\phi = \frac{X_C - X_L}{R} = \frac{31.8 - 16.34}{23}$

$= 0.67$

, ∴ $\phi = 33.9°$ → (2)



, $Z_1 = 8\,\Omega$, $Z_2 = \sqrt{X_L^2 + R^2} = \sqrt{(16.34)^2 + 5^2} = 17\,\Omega$

, $Z_3 = \sqrt{X_C^2 + R^2} = \sqrt{(31.8)^2 + 10^2} = 33.34\,\Omega$

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* Resonance Case *
حالة الرنين

- Conditions :- $V_L = V_C$, $Z = R$, $I = \frac{V}{R}$, $X_L = X_C$

, $F = \frac{1}{2\pi\sqrt{LC}}$ → resonance frequency ترددالرنين

- Resonance frequency doesn't depend on R and it depends only on L, C
- لا يعتمد تردد الرنين على المقاومة ولكنه يعتمد فقط على الحث الذاتي للملف وسعة المكثف.
وتكون للدائرة خصائص أومية فقط

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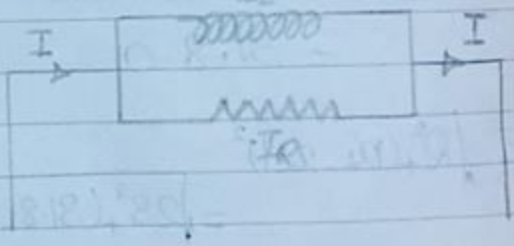
* R-L Circuits «in parallel» *

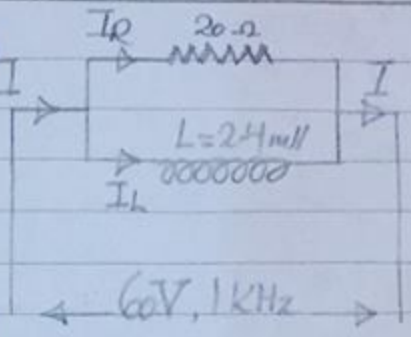
$I = \sqrt{I_L^2 + I_R^2}$, $I_R = \frac{V}{R}$, $I_L = \frac{V}{X_L}$

, $\tan \phi = \frac{I_L}{I_R} = \frac{I_L}{I} = \frac{I_R}{I}$



- Problem :- A 20 Ω resistor is Connected in parallel with inductance L = 2.4 mH across a power Supply of 60 V, 1 KHz
- Calculate : 1- The Current in each branch « I_L, I_R »
2- The Supply «total» Current « I »
3- Circuit phase angle « Ø »
4- Circuit impedance « Z »
5- Power Consuming

$X_L = 2\pi FL = 2\pi \times 1 \times 1000 \times 2.4 \times 10^{-3} = 15.08\ \Omega$



$I_L = \frac{V}{X_L} = \frac{60}{15.08} = 3.98\ A$

$I_R = \frac{V}{R} = \frac{60}{20} = 3\ A$

$I = \sqrt{I_L^2 + I_R^2} = \sqrt{(3.98)^2 + 3^2} = 4.98\ A$

$\tan\phi = \frac{I_L}{I_R} = \frac{3.98}{3} = 1.33 \quad , \therefore \phi = 52.99^\circ$

$Z = \frac{V}{I} = \frac{60}{4.98} = 12\ \Omega$

$P_w = I_R^2 R = 3^2 \times 20 = 180\ watt$

* لا يوجد استهلاك طاقة في الملف لأنه يخزن الطاقة على هيئة مجال مغناطيسي.