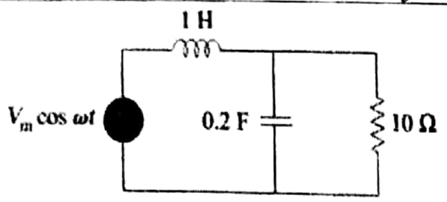
Model Answer

Benha University
Faculty of Engineering- Shoubra
Electrical Engineering Department
1st Year (Communications & Electronics)

Mid-Term Exam
Date: 20/03/2018
ECE 122 Electrical Circuits (2)
Duration : 1 Hour

1. *Calculate the resonant frequency of the circuit in Figure (1)* ***(5 marks)***



Answer of Q1

$$Z = j\omega L + \frac{10 \times 1/j\omega C}{10 + 1/j\omega C}\left(\frac{j\omega C}{j\omega C}\right)$$

$$Z = j\omega \cdot 1 + \frac{10}{1+j2\omega} \cdot \left(\frac{1-j2\omega}{1-j2\omega}\right)$$

$$Z = j\omega + \frac{10}{1+4\omega^2}(1-j2\omega)$$

$$= j\omega + \frac{10}{1+4\omega^2} - \frac{j20\omega}{1+4\omega^2}$$

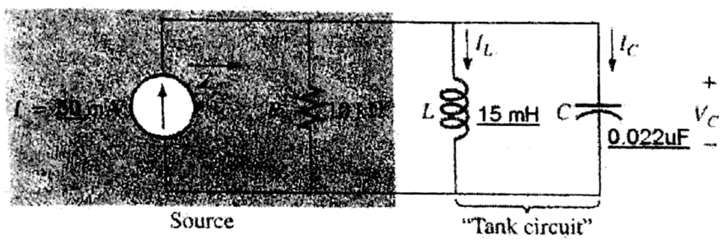
$$Im(Z) = \omega - \frac{20\omega}{1+4\omega^2} = 0$$

$$\therefore 1+4\omega^2 = 20 \quad \therefore 4\omega^2 = 19 \quad \therefore \omega^2 = \frac{19}{4}$$

$$\therefore \omega = \sqrt{\frac{19}{4}} = 2.179 \text{ rad/sec}$$

$\times$ $\omega = \frac{1}{\sqrt{LC}}$ ملحوظة لا يجوز التعويض بالقانون

2. *For the circuit shown in figure (2)* ***(10 marks)***
   (a) *If the frequency of the applied source is 12KHz , find the total impedance of the circuit in polar form.*
   (b) *Is the circuit is more inductive or more capacitive?*
   (c) *Find the total impedance of the circuit at resonance*



3. *It is required to broadcast a* ***shoubra radio*** *station which detected through FM radio. Design a suitable practical parallel resonance circuit using coil has impedance of* ***10+j3000Ω*** *to verify the required broadcasting. The circuit has to be heard between (****89****MHz and* ***91*** *MHz) and very clear at 90MHz.* ***Don't use any approximations. (10 marks)***

Answer of Q2

ⓐ $Y = \frac{1}{R} + j\left(\omega C - \frac{1}{\omega L}\right)$

$$= \frac{1}{10^4} + j\left(2\pi \times 12 \times 10^3 \times 0.022 \times 10^{-6} - \frac{1}{2\pi \times 12 \times 10^3 \times 15 \times 10^{-3}}\right)$$

$$= 10^{-4} + j7.65 \times 10^{-4}$$

$$= 7.715 \times 10^{-4} \angle 82.55^\circ$$ (5 marks)

$$\therefore Z = \frac{1}{Y} = 1296.16 \angle -82.55^\circ \ \Omega$$

$$X_L = 2\pi f L = 1130.4 \ \Omega$$

$$X_C = \frac{1}{2\pi f C} = 603.165 \ \Omega$$

ⓑ $X_L > X_C$ in parallel $\therefore$ Capacitive

(3 marks)

Answer of Q2

ⓒ at Resonance

$Z = R = 10 \text{ k}\Omega$ (2 marks)

(3) $X_{Lp} = \frac{X_L^2 + R_L^2}{X_L} = \frac{(3000)^2 + (10)^2}{3000} \approx \boxed{3000\,\Omega}$ (2marks)

$R_p = \frac{R_L^2 + X_L^2}{R_L} = \frac{(3000)^2 + (10)^2}{10} = \boxed{900k\Omega}$ (2marks)

$BW = f_2 - f_1 = 91 - 89 = 2\,MHz = 2 \times 10^6\,Hz$ (4marks)

$= 2\pi(2 \times 10^6)$ rad/s $= 12.56 \times 10^6$ rad/s

$BW_{rad/s} = \frac{1}{RC} \Rightarrow BW = \frac{f_0}{Q}$ $\therefore Q = \frac{f_0}{BW} = \frac{90}{2} = \boxed{45}$ (marks)

$Q = \frac{R_t}{\omega L}$ $\therefore$ $R_t = Q\omega L = 45 \times (2\pi \times 90 \times 10^6) L$

$L = \frac{X_L}{\omega_0} = \frac{3000}{2\pi(90 \times 10^6)} = 5.3\,\mu H$

$\therefore R_t = 45 \times (2\pi \times 90 \times 10^6)(5.3 \times 10^{-6}) = \boxed{135\,k\Omega}$ → (2marks)

$\frac{1}{R_t} = \frac{1}{R_p} + \frac{1}{R_s}$ $\therefore \frac{1}{135\,k} = \frac{1}{3000} + \frac{1}{R_s}$ $\therefore \boxed{R_s = 158.8\,k\Omega}$ (2marks)

$Q = \omega R_t C = 45 = (2\pi \times 90 \times 10^6)(135 \times 10^3) C$

$\boxed{\therefore C = 5.89 \times 10^{-13} F}$ (2marks)