Q- The cut-off frequencies of a series resonant circuit are 5400 Hz and 6000 Hz.

a. Find the Bandwidth of the circuit.

At resonant frequency f_0 the current in the circuit is the maximum. For the values of the frequencies less or more than the resonant frequency, the current is less than the maximum. For any current less than maximum, there are two frequencies, one f_1 is more and the other f_2 is less than the resonant frequency called the cut off frequencies where current in the circuit 70.7% of the maximum and they are symmetrical to the resonant frequency. The difference of these frequencies is called bandwidth.

Here the cut-off frequencies are f_1 = 6000 Hz and f_2 = 5400 Hz hence the bandwidth is given by

$$f_1 - f_2 = 6000 - 5400 = 600 \text{ Hz}$$

b. If quality factor Q = 9.5, find the resonant frequency of the circuit.

Let the two frequencies are separated from the resonant frequency f_0 by Δf than

$$f_1 = f_0 + \Delta f \quad \text{----------------------------} \quad (1)$$

And $$f_2 = f_0 - \Delta f \quad \text{----------------------------} \quad (2)$$

Gives $f_0 = \frac{f_1+f_2}{2} = \frac{6000+5400}{2} = 5700\ Hz$

In other way, the quality factor Q is defined and calculated by

$$Q = \frac{f_0}{2\Delta f}$$

c. If the resistance of the circuit is 2 Ω, find the value of X_L and X_C at resonance.

The Quality factor is also equal to the ratio of the inductive reactance or the capacitive reactance to the resistance at resonance frequency in the circuit and hence it is given by

$$Q = \frac{f_0}{2\Delta f} = \frac{X_L}{R} = \frac{X_C}{R}$$

Hence, we have

$$X_L = X_C = Q*R = 0.95*2 = 1.9\Omega$$

d. Find the value of L and C at resonance.

As we know $X_L = L\omega = L\,2\pi f$

The value of L at resonance is given by

$$L = \frac{X_L}{2\pi f_0} = \frac{1.9}{2*3.14*5700} = 5.2 * 10^{-5}\ H$$

And as $X_C = 1/(C\omega) = 1/(C*2\pi f)$

The value of C at resonance is given by

$$C = \frac{1}{2\pi f_0 X_C} = \frac{1}{2*3.14*5700*1.9} = 1.47 * 10^{-5}\ F$$