

Problem Set 6 Hint Sheet**Q3**

Apply Ohm's law: $V = IR$

Only magnitude is affected in a resistor since V and I are in phase in a resistor.

Q4

Impedance Z describes the relationship between current and voltage

Apply $Z = V/I = 1/j\omega C$

Therefore V lags I by 90° (because of $-j$) and V is reduced by $1/\omega C$ relative to I

Magnitude of voltage = $4/\omega C$

Phase of voltage relative to the current = $25^\circ - 90^\circ$

Q5

Impedance Z describes the relationship between current and voltage

For an inductor: $Z = V/I = j\omega L \Rightarrow V$ leads I by 90° (see j) and V is larger than I by ωL

\Rightarrow Magnitude of current = $60/\omega L$

\Rightarrow Phase of current relative to the voltage = $-65^\circ - 90^\circ$

Q6

Compare the phase of V relative to $I \Rightarrow V$ leads I by 90°

Therefore apply the impedance formula for an inductor: $Z = V/I = j\omega L$

Q7

Apply voltage divider rule for both cases using the impedance expressions ($j\omega L$, $1/j\omega C$)

Q8

R_2 in series with $C \Rightarrow Z_1$

R_1 in series with $L \Rightarrow Z_2$

Total impedance seen by the source: $Z = Z_1 \parallel Z_2$

$$Z = \left(R_2 + \frac{1}{j\omega C} \right) \parallel (R_1 + j\omega L) = \frac{\left(R_2 + \frac{1}{j\omega C} \right) (R_1 + j\omega L)}{R_1 + R_2 + j\left(\omega L - \frac{1}{\omega C} \right)}$$

Q9

$$Z_{eq} = R + \frac{1}{j\omega C} + j\omega L$$

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

Q10

Find admittance first and convert to impedance. In this case, given that the components are in parallel, it is easier to find the admittance

$Y = 1/Z = j\omega C + 1/R + 1/j\omega L \Rightarrow Z = 1.664 \angle -0.983^\circ \Omega$ (Note that the phase is given in radians here)

Finally apply $V = IZ \Rightarrow V = 16.64 \angle -0.983^\circ V$