Department of Mechanical, Materials and Manufacturing Engineering

The University of Nottingham

Electromechanical Devices MMME2051EMD

Exercise Sheet 3 – Alternating Current and AC Circuits

3.1 An impedance of $10+j15\ \Omega$ is supplied from a 10V (rms) 50 Hz supply. What is the current expressed in Cartesian (complex) form and in polar form, and does the current lead or lag the voltage? (Hint: use Ohm's law, replacing resistance with impedance).

0.308 – j0.461 A; 0.5547 A ∠–56.3°; current lags voltage

3.2 Find the magnitude and phase of the current in the circuit shown in Fig. 3.1 using **polar notation**.

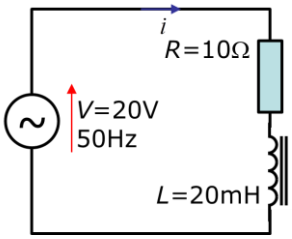

Fig. 3.1

1.69 A, –32° as before

3.3 This question was introduced in the lecture and illustrates that simple circuit laws (in this case, Kirchhoff's current law as well as Ohm's law) still apply to AC. What is current I, expressed both in Cartesian (complex) and polar form, and does the current lead or lag the voltage?

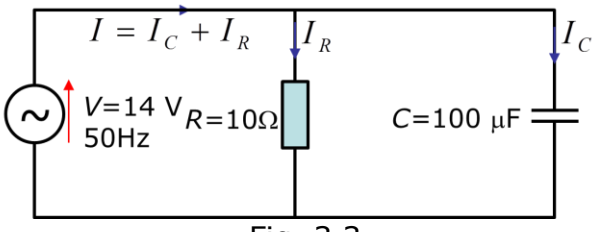

Fig. 3.3

1.4+0.44j A; 1.47 A ∠17.4°

3.4 A 10V (rms) 1kHz supply feeds a 470Ω resistor in series with a 470nF capacitor. Using **Cartesian co-ordinates** calculate the capacitive reactance, complex impedance, magnitude of the impedance, current (in Cartesian co-ordinates), magnitude of the current, phase angle, and power

factor. Re-express the impedance in polar form and hence repeat the current calculations using polar co-ordinates and confirm that you obtain the same answers!

338.6Ω, (470-j338.6)Ω, 579.3Ω, (14+j10.1)mA, 17.3mA, ∠+35.8°, 0.811 leading. Impedance in polar form is 579.3 Ω∠–35.8°

3.5 A current of 0.5 + *j*0.6 A flows through an impedance of $10 - j\,15\ \Omega$. What is the voltage across this impedance, expressed in Cartesian and polar form? Does this impedance have a capacitive or inductive component?

$14 - j1.5$ V; 14.01 V∠–6.12°; load is likely to be made up of a resistive and capacitive component.

3.6 A 110V (rms) 60Hz supply feeds a 1kΩ resistor in series with a 2H inductor. Calculate the power dissipated in the circuit.

7.71W

3.7 Two impedances of value $4 + j3\ \Omega$ and $2 + j5\ \Omega$ are placed in parallel. What is the equivalent impedance expressed in Cartesian form?

$1.66 + j2.12\ \Omega$

3.8 A 240V (rms) 50Hz supply feeds a 470Ω resistor in series with a 1H inductor. Using **Cartesian co-ordinates** calculate the inductive reactance (expressed as a complex number), complex impedance, magnitude of the impedance, current (in Cartesian co-ordinates), magnitude of the current, phase angle, and power factor.

314.2Ω, (470+j314.2)Ω, 565.3Ω, (0.353-j0.236)A, 0.425A,∠-33.8°lagging, 0.831.

3.9 A 240V(rms) 50Hz supply feeds a load comprising a 50Ω resistor connected in series with a 100mH inductor. Calculate the inductive reactance, circuit impedance, current magnitude and phase angle, power factor, and power dissipated in the load.

The 100mH inductor is replaced by a capacitor. With the same supply voltage and frequency the current **magnitude** remains unchanged. Calculate the capacitance.

31.4Ω, 59.1Ω∠+32.1°, 4.06A, ∠–32.1°lagging, 0.847, 825W, 101μF.