The University of Sheffield
Department of Electronic and Electrical Engineering

EEE117 Problem Sheet

a.c. Sources and Circuits

Q1 Express each of the following voltages in polar form. (*remember that they must all be referred to the same base reference that can be either a sin or a cos*)

$v_1 = 212\sin(\omega t + 45^o)$ $\quad v_2 = 141\sin(\omega t - 90^o)$ $\quad v_3 = 127\cos(\omega t + \frac{\pi}{6})$

$v_4 = 85\cos(\omega t - 45^o)$ $\quad v_5 = 141\sin(\omega t + 180^o)$ $\quad v_6 = 100\cos(\omega t - \frac{\pi}{3})$

[$212\angle 45^o$, $141\angle -90^o$, $127\angle 120^o$, $85\angle 45^o$, $141\angle 180^o$, $100\angle 30^o$][these answers use sinωt as phase reference]

[$212\angle -45^o$, $141\angle -180^o$, $127\angle 30^o$, $85\angle -45^o$, $141\angle 90^o$, $100\angle -60^o$][these answers use coswt as phase reference. Note that $+180^o$ is indistinguishable from -180^o]

Q2 Convert the following complex voltages into polar form,

$(2 - j\,2)$; $(3 + j\,8)$; $(-5 + j\,3)$; $(-4 - j\,4)$; $(2 - j\,2)(3 + j\,8)$; $(-5 + j\,3) - (-4 - j\,4)$

[$2.83\angle -45^o$; $8.54\angle 69.4^o$; $5.83\angle 149^o$; $5.66\angle 225^o$ or $5.66\angle -135^o$; $24.2\angle 24.4^o$; $7.1\angle 98.1^o$]

Q3 Convert the following polar voltages into an $(a + jb)$ form,

$6\angle 45^o$; $50\angle -170^o$; $4\angle 105^o$; $3\angle -90^o$; $(5\angle -30^o)(6\angle 120^o)$; $(3\angle 15^o + 3\angle 135^o + 3\angle -105^o)$

[$(4.2 + j\,4.2)$; $(-49.2 - j\,8.7)$; $(-1.0 + j\,3.9)$; $(0 - j\,3)$; $(0 + j\,30)$; $(0 + j\,0)$]

Q4 Use phasor diagrams to evaluate the sum of each of **(i)**, **(ii)** and **(iii)** below and give your answers in polar form.

(i) $i_1 = 14\sin(\omega t + 45^o)$ and $i_2 = 14\sin(\omega t + 45^o)$

(ii) $v_1 = 14.14\sin(\omega t + 13^o)$ and $v_2 = 14.14\sin(\omega t + 103^o)$

(iii) $i_1 = 3\sin(\omega t - 145^o)$ and $i_2 = 3\sin(\omega t - 25^o)$ and $i_3 = 3\sin(\omega t + 95^o)$

[$28\angle 45^o$, $20\angle 58^o$, 0]

Q5 A series circuit consisting of two unknown components draws a current of $11\cos(800t + 140^o)$ when driven by a voltage of $280\cos(800t + 150^o)$.

(i) What two components must be involved? [L and R]

(ii) Find values for those components. [25 Ω, 5.5 mH]

(iii) Calculate the power dissipated in the circuit. [1.52 kW]

Q6 A coil draws 10 A when connected to a 230 Vrms 50 Hz voltage source. If the coil resistance is 2 Ω, find its inductance. Using a phasor diagram, or by other means, find the phase of the current with respect to the voltage. [73 mH, – 85°]

Q7 $|Z|$ of a particular RC series combination is 110 Ω. If $R = 47$ Ω and $f = 100$Hz find the reactance of the capacitor and hence its value. Use a phasor diagram to find the phase of the current with respect to the driving voltage. [99.5 Ω, 16μF, 64.7°]

Q8 For the circuit of figure 8, find the magnitude and phase of I and V_C with respect to V_I for

(i) $f = 50$ Hz [0.30∠73°; 18.8∠– 17°]

(ii) $f = 150$ Hz [0.14∠– 82.2°; 2.9∠– 172°]

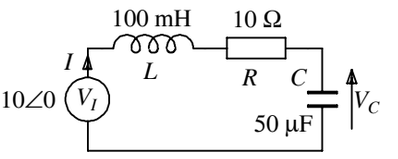

Figure 8

Q9 For the circuit of figure 9,

(i) Draw a phasor diagram to sum the voltages in the loop and hence find the magnitude of V_3. [41 V]

(ii) Express V_{S1} and V_{S2} in an $a + jb$ form. [(40 + j 0); (10.3 + j 28.2)]

(iii) Find I in the form a + jb and evaluate its magnitude and phase. What is the reference phase with respect to which the phase of I has been calculated? [0.56∠– 92.4; All phases w.r.t V_{S1}]

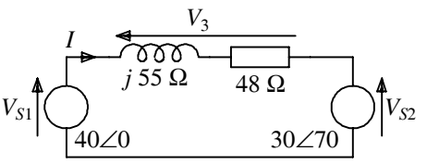

Figure 9

Q10 For the circuit of figure 10,

(i) Calculate Z and express it in $a + jb$ and polar forms. [(5 + j 9.3); 10.6∠61.7°]

(ii) What components might Z be composed of? [L (j 9.3 Ω) in series with R (5 Ω)]

(iii) Write down I and Z if the source is modified to 50∠0. [2.5∠– 60°; (5 + j 9.3)]

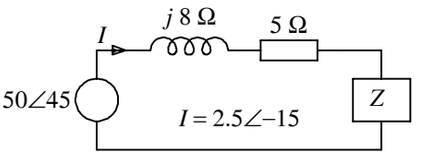

Figure 10

Q11 In figure 11 all the resistances and reactances given are in Ω and the sources are specified by their rms values. There is no phase difference between the two sources. Use loop analysis to find I in the form (a+ jb) and evaluate the power delivered to the circuit by each of the two sources. [(1– j1.5), 0, 5 W]

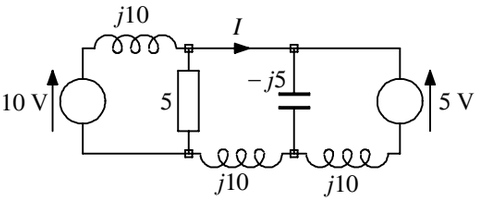

Figure 11