PROBLEM SHEET 7

Complex notations

Many problems here are identical to problems in the problem sheets 5 and 6, but now you are asked to solve them using the complex notations.

1. Determine: a) $\sqrt{j}$; b) $\sqrt{-j}$
2. Two impedances Z_1 and Z_2 are connected in series. Determine the complex impedance and complex admittance of the circuit if:
   a) $Z_1 = 5 + 10j\ \Omega$ and $Z_2 = 3 - 4j\ \Omega$
   b) $Z_1 = -130j\ \Omega$ and $Z_2 = 20 - 10j\ \Omega$
   c) $Z_1 = 0.08 + 0.2j\ \Omega$ and $Z_2 = 0.05 - 0.01j\ \Omega$
   d) $Z_1 = 142 + 68j\ \Omega$ and $Z_2 = 213 - 335j\ \Omega$
3. A circuit consists of a resistor $R = 2\ \text{k}\Omega$ and a coil $L = 0.2$ H which are connected in series. Determine complex impedance and complex admittance of the circuit:
   a) at frequency $f = 500$ Hz;
   b) at angular frequency $\omega = 12570$ rad/sec
4. Two sinusoidal EMFs of peak values 50 V and 20V respectively but differing in phase by 30^o are induced in series in the same circuit. Find resultant EMF using the complex notations.
5. Three EMFs $e_A = 50\sin\omega t$, $e_B = 80\sin(\omega t - \pi/6)$ and $e_C = 60\cos\omega t$ are induced in three coils connected in series. Determine a) the maximum value of the resultant EMF, b) its phase relative to the first EMF using the complex notations.
6. Four EMFs, $e_1 = 25\sin\omega t$, $e_2 = 30\sin(\omega t + \pi/6)$, $e_3 = 30\cos\omega t$ and $e_4 = 20\sin(\omega t - \pi/4)$ are connected in series, so that the sum of the four EMFs is obtained. Find using the complex notations a) the amplitude of the total voltage; b) its phase difference with respect to e_1 ; c) its phase difference with respect to e_3 .
7. A coil of inductance 0.1 H and negligible resistance is connected in series with a 25 Ω resistor. The circuit is connected to a voltage source 230 V, 50 Hz. Determine: a) the current in the circuit; b) the potential difference across the coil; c) the potential difference across the resistor; d) the phase angle in the circuit using the complex notations.
8. A 15 Ω resistor is connected in series with a coil of inductance 0.08 H and negligible resistance. The circuit is connected to a 240 V, 50 Hz supply. Determine: a) the reactance of the coil; b) the impedance of the circuit; c) the current in the circuit; d) the phase difference for the current with respect to the supply voltage using the complex notations.
9. A 90 Ω resistor is connected in series with a 22 μF capacitor. The circuit is connected to a 240V, 50 Hz supply. Determine: a) the reactance of the capacitor; b) the impedance of the circuit; c) the current in the circuit; d) the phase difference for the current with respect to the supply voltage using the complex notations.
10. A circuit having a resistance of 12 Ω, an inductance of 0.15 H and a capacitance of 100 μF in series, is connected across a 100 V, 50 Hz supply. Determine: a) the impedance; b) the current;

c) the voltages across the resistor, the capacitor and the coil; d) the phase difference between the current and the supply voltage using the complex notations.

11. Two impedances Z_1 and Z_2 are connected in parallel. Determine the complex impedance and complex admittance of the circuit if:
    a) $Z_1 = 5 + 10j\ \Omega$ and $Z_2 = 3 - 4j\ \Omega$
    b) $Z_1 = 142 + 68j\ \Omega$ and $Z_2 = 213 - 335j\ \Omega$
12. A circuit consists of a resistor $R_0 = 2\ \text{k}\Omega$ and a capacitor $C = 40$ nF which are connected in parallel to a power supply of 100 V at frequency $f = 1000$ Hz. Determine complex impedance and complex admittance of the circuit.
13. The currents in three circuits connected in parallel to a voltage source are: a) 4 A in phase with the applied voltage; b) 6 A lagging the applied voltage by 30^o; c) 2 A leading the applied voltage by 45^o. Plot the phasor diagram for these currents. Determine using the complex notations the total current taken from the source and its phase angle with respect to the supply voltage.
14. Two impedances are connected in parallel to the supply, the first takes a current of 40 A at a lagging phase angle of 30^0, and the second a current of 30 A at a leading phase angle of 45^0. Using complex notations, find the total current taken from the supply and its phase angle.
15. For the frequency 100Hz, the reactances of a capacitor and an inductor are 15 Ω each. The resistance of a resistor is 150 Ω. The power supply produces 150V at 100Hz. Using complex notations, determine the impedance, the overall current and the phase angle for the circuit which consists of:
    a) The resistor and the capacitor connected in parallel to the power supply.
    b) The resistor and the inductor connected in parallel to the power supply.
    c) The resistor, the capacitor and the inductor connected in parallel to the power supply.
16. Solve the problem discussed at the lecture using the following values: $R_1 = 50\ \Omega$, $R_2 = 75\ \Omega$, $L = 0.318$ H, $C = 159\ \mu$F, $\mathcal{E} = 230$ V and frequency $f = 50$ Hz.
17. A parallel circuit consists of two branches A and B. Branch A has a resistance of 10 Ω and an inductance of 0.1 H in series. Branch B has a resistance of 20 Ω and a capacitance of 100 μF in series. The circuit is connected to a supply of 230 V at 50 Hz. Determine the overall current taken from the supply and its phase using the complex notations.
18. **ASSIGNMENT.** A circuit consists of three blocks connected in series. The first block consists of a resistor of 31 Ω and a capacitance of 100 μF connected in parallel. The second block consists of a resistor of 50 Ω. The third block consists of a resistor of 20 Ω and an inductance of 0.11 H connected in parallel. The circuit is connected to a supply of 230 V at 50 Hz. Determine the overall current taken from the supply and its phase using the complex notations.