ECE 3614
FUNDAMENTALS OF ENERGY SYSTEMS

HOMEWORK SET #1

SINGLE-PHASE POWER

1-1. The phasor voltage across a load impedance in a 60 Hz single-phase network is $6\sqrt{2}\angle30^\circ$ V-rms. The phasor current flowing through the load is $\sqrt{2}\angle10^\circ$ A-rms. Determine (a.) the average power supplied to the load (b.) the expression for the instantaneous power across the load (c.) the power factor at the load.

Ans. (a.) $P = 11.28$ W, (b.) $p(t) = 11.28 + 12\cos(754t + 40^\circ)$ W, (c.) $PF = 0.940$ lagging.

1-2. A complex load impedance fed by a 2400 V-rms supply absorbs 288 kW at a power factor of 0.8 lagging. Determine the complex load impedance $Z_L$.

Ans. $Z_L = (12.8 + j 9.6)$ Ω

1-3. Two loads $Z_{L1}$ and $Z_{L2}$ are connected in parallel and supplied from a single-phase 240 V-rms source. The two loads in parallel draw a total real power of 400 kW at a power factor of 0.8 lagging. The load $Z_{L1}$ draws 120 kW at a power factor of 0.96 leading. Determine the complex power for $Z_{L2}$. [Hint: The total complex power delivered to the parallel loads is the algebraic sum of the complex powers delivered to the individual loads (conservation of power)].

Ans. $S_2 = (280 + j 335)$ kVA

1-4. The voltage $v(t) = 678.8\cos(\omega t + 45^\circ)$ is applied to a load impedance consisting of a resistor in series with a capacitor. The overall load impedance is $Z_L = (10 - j 25)$ Ω. Determine (a.) the instantaneous power in the resistor (b.) the instantaneous power in the capacitor (c.) the complex power for the load (d.) the load power factor.

Ans. (a.) $3.178 [1+\cos(2\omega t + 226.4^\circ)]$ kW (b.) $7.944\sin(2\omega t + 226.4^\circ)$ kW (c.) $S = (3.178 + j 7.944)$ kVA (d.) $PF = 0.371$ leading

1-5. Two voltage sources $[V_1 = 120\angle-5^\circ, \ V_2 = 100\angle0^\circ]$ are connected by a transmission line impedance of $Z_{tl} = (1+j7)$ Ω. Determine (a.) the complex power produced by the two sources (b.) the complex power associated with the line impedance (c.) the real power being generated or dissipated in the sources and the line.

Ans. (a.) $S_1 = (-97.5+j363.3)$ VA, $S_2 = (107.3-j294.5)$ VA, (b.) $S_{tl} = (9.8+j68.8)$ VA (c.) $V_1$ source dissipates 97.5 W, $V_2$ source generates 107.3 W, transmission line dissipates 9.8 W
1-6. Two impedances \( Z_1 = (0.8+j5.6) \ \Omega, \ Z_2 = (8-j16) \ \Omega \) and a single-phase motor are connected in parallel across a 60 Hz 200 V-rms source. The motor draws 5 kVA at a power factor of 0.8 lagging. Determine (a.) the complex powers \( S_1 \) and \( S_2 \) for the two impedances and \( S_3 \) for the motor (b.) the overall complex power drawn from the source, the source current, and power factor for the overall load (c.) the capacitance necessary to produce a power factor of unity for the overall load.

**Ans.** (a.) \( S_1 = (1+j) \text{ kVA}, \ S_2 = (1-j) \text{ kVA}, \ S_3 = (4+j3) \text{ kVA} \) (b.) \( S = (6+j8) \text{ kVA}, \ I_s = 50 \angle -53.13^\circ \text{ A-rms}, \ PF = 0.6 \) lagging (c.) 530.5 \( \mu \)F