

Quiz 1, EE 303, 2017, Dr. McCalley

Closed book, closed notes, no calculator, no computer, no communication device

Answer all questions on this sheet of paper.

1. **Short-answer (48):** The rms voltage and current of a single phase inductive load are 110V and 10A, respectively. The frequency of the voltage waveform is 60Hz. The instantaneous power consumed by the load has no average value (i.e., has average value=0).

a. (6) What is the frequency of the current, in radians/sec?

$$2\pi(60)$$

b. (6) What is the frequency of the instantaneous reactive power, in radians/sec?

$$4\pi(60)$$

c. (6) What is the peak-to-peak amplitude of the current?

$$2(\sqrt{2})(10) \text{ A}$$

d. (6) What is the real (active) power consumed by the load?

Since the instantaneous power consumed by the load has average value=0, the real power=0.

e. (6) What is the reactive power consumed by the load?

$Q = VI \sin \theta = (110)(10) \sin \theta$; since we know average power is 0, then load is entirely reactive, and so $\theta = 90^\circ$ or $\theta = -90^\circ$. But the problem statement also tells us the load is inductive, therefore current lags voltage, i.e., $\theta = \theta_v - \theta_i = 90^\circ$, and so $Q = VI \sin \theta = (110)(10) \sin(90^\circ) = 1100 \text{ vars}$

f. (6) What is the power factor of the load?

$$\text{pf} = \cos \theta = \cos 90^\circ = 0.$$

g. (6) Write down time-domain expressions for voltage and current.

$$v(t) = \sqrt{2}(110) \sin(\omega t); \quad i(t) = \sqrt{2}(10) \sin(\omega t - \pi/2)$$

h. (6) Write down phasor expressions for voltage and current.

$$\mathbf{V} = 110 \angle 0^\circ; \quad \mathbf{I} = 10 \angle -90^\circ$$

2. **True-false (30 pts, 6 each):**

—F—

(a) Overhead circuits require conductors to be insulated in order to protect wildlife.

—T—

(b) The Energy Management System (EMS) is the software system in control center computers that provides the interface between human operators and the power grid, allowing remote monitoring and control.

—T—

(c) Lack of tree-trimming was a major issue behind the cascading sequence of events that brought on the 2003 blackout in the northeast United States.

—F—

(d) The US presently obtains over 50% of all of its energy from coal and 10% from natural gas.

—T—

(e) In 2015, Iowa was the top state in the nation in regards to percent of its total annual electric energy that was produced from wind.

3. **Calculation (22 pts):** A three phase load has a per phase impedance, connected in Y, of $100 + j30 \Omega$. The line-to-line voltage magnitude at the load is 1500V. Assuming that the line-to-neutral voltage of *phase-a* is the reference, calculate the current flowing into *phase-a* of the load.

$$V_{AN} = \frac{1500}{\sqrt{3}} = 866.025 \text{ V} \Rightarrow I_A = \frac{V_{AN}}{Z_{LOAD}} = \frac{866.025}{100 + j30} = 7.945 - j2.384 \text{ A} = 8.295 \angle -16.7^\circ \text{ A}$$