

Quiz 1, EE 303, Spring 2019, Dr. McCalley

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

Answer all questions on this sheet of paper.

1. **Short-answer (42):** The rms voltage and current of a single phase load comprised of linear time-invariant elements are 110V and 10A, respectively. The voltage waveform crosses zero $\pi/2$ radians ahead of the current waveform. The frequency of the voltage waveform is $\omega=377$ rad/sec.

- a. (7) What is the frequency of the current waveform?

Also $\omega=377$ rad/sec.

- b. (7) What is the real (active) power consumed by the load?

Since the current is 90° behind the voltage, the load is 100% inductive. Thus, the real power consumed by the load=0.

- c. (7) What is the reactive power consumed by the load?

$Q=VI\sin\theta=(110)(10)\sin\theta$; since we know the load is entirely inductive, then $\theta=\theta_v-\theta_i=90^\circ$, and so $Q=VI\sin\theta=(110)(10)\sin(90^\circ)=1100\text{vars}$.

- d. (7) What is the power factor of the load?

$pf=\cos\theta=\cos90^\circ=0$.

- e. (7) Write down time-domain expressions for voltage and current. Assume the voltage is the reference.

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

- f. (7) Write down phasor expressions for voltage and current.

$V=110\angle 0^\circ$; $I=10\angle -90^\circ$.

2. **True-false (35 pts, 7 each):**

- F— (a) The amount of MW generating capacity in the United States is about 37 Quads.
—F— (b) In the US, independent system operators (ISOs) own about half of the generation and transmission facilities, with most of the other half being owned by investor-owned utilities, municipals, cooperatives, and Federal Power Authorities.
—T— (c) In the US, in 2018, natural gas led all other resources in terms of percentage electricity generation, with coal, nuclear, and wind 2nd, 3rd, and 4th, respectively.
—T— (d) In the US, in 2017, the energy lost as a percent of total energy obtained from all primary resources, was about 66%, much of which was due to heat escaping from combustion processes used in thermal power plants and in vehicles for transportation.
—F— (e) The levelized cost of energy for a power plant is the cost of operating that power plant for a year divided by the total energy produced by that power plant in that year.

3. **Calculation (23 pts):** The current flowing from the a -phase of a Wye-connected three phase source is $34.64\angle 0^\circ$ amperes. The a -phase line-to-neutral voltage of the source is $3237.8\angle 3.07^\circ$ volts. Assuming the system is balanced, compute the three-phase real power supplied by the source and the three-phase reactive power supplied by the source. You need to provide expressions for three-phase real and three-phase reactive power, including the appropriate numerical values, so that it is clear you know how to make the computation. Identify appropriate units for your answers.

$$\begin{aligned} S_{3\phi} &= 3V_s I_{Load}^* = 3 \cdot (3237.8\angle 3.07^\circ) \cdot (34.64\angle 0^\circ) = 336,472\angle 3.07^\circ \text{VA} \\ &= 336,472(\cos(3.07^\circ) + j \sin(3.07^\circ)) \\ &= 335,990 \text{watts} + j18,020 \text{vars} = P_{3\phi} + jQ_{3\phi} \end{aligned}$$

Alternatively:

$$\begin{aligned} P_{3\phi} &= 3(3237.8)(34.64)\cos(3.07^\circ) = 336472\cos(3.07^\circ) = 335.99\text{kW} \\ Q_{3\phi} &= 3(3237.8)(34.64)\sin(3.07^\circ) = 336472\sin(3.07^\circ) = 18.02\text{kVAR} \end{aligned}$$