1.

a. The average value of any sinusoid is 0. Thus, the average voltage is 0 V and the average current is 0 A.

b. This is easily done in the phasor domain.

$v(t) = 30\ cos(\omega t + 25^{o}) \rightarrow V = \frac{30}{\sqrt{2}}\angle 25°$

$i(t) = 2\ sin(\omega t - 10^{o}) \rightarrow I = \frac{2}{\sqrt{2}}\angle - 100°$

$S = VI^* = (\frac{30}{\sqrt{2}}\angle 25°)\ (\frac{2}{\sqrt{2}}\angle 100°) = 30\angle 125°\ VA = (-\ 17.2 +\ j\ 24.6)\ VA$

c. The real power is the real part of the apparent power, while the reactive power is the imaginary part of the apparent power. Thus:

$P = -\ 17.2\ W$

$Q = 24.6\ Var$

It is apparent here that the device is supplying real power while consuming reactive power due to the respective signs of the answers.

2. For the statements below, **circle** each correct statement. To receive full marks for each answer, we not only discourage guesses, but you **must** provide a justification of why you chose to circle or not circle each statement.

   a. Power Conversion

      i. The DC to AC power conversion can be performed only with a non-linear circuit.

         True. Inverters, typically, use some type of switching element (such as a transistor) to perform DC-AC conversion. Such elements are non-linear. [Lecture 9 notes]

      ii. The *Bipolar Junction Transistor* is the most common active switch in power conversion.

         False. In the 80’s, the most common switch was the IGBT. Today, MOSFETs are used instead. [Lecture 9 notes].

      iii. A US level one charger uses approximately a 12-A current at 240 V.

False. A *US* level one charger uses 120 V, not 240 V. [Lecture 12b notes]

iv. In a DC-DC converter circuit with ideal switches and *RLC* components, the average voltage across an inductor is 0 *V* and the average current through a capacitor is 0 *A*.

True. In Periodic Steady State, the derivates of voltage and current across an inductor and a capacitor are 0 respectively. Hence, $v = L\ di/dt$ and $i = C\ dv/dt$ are both equal to 0 on average. Therefore, the average voltage across an inductor is 0 *V* and the average current through a capacitor is 0 *A*. [Lecture 12a notes]

b. *EV* Integration Into Today's Grids

i. At a specified time, the reserves margin at the load at that time is simply the difference between the total capacity of the resources which supply the generated outputs and the load. The reserves margin reaches its lowest value at the peak load in the period of interest

True. This is the definition of reserves margin is. For a specified period of interest, the difference between the two quantities in the definition is smallest at the largest load value during the period. [Lecture 11, slide 5 illustrates the definition]

ii. DRRs reduce their loads in response to incentives the grid operator provides to curtail electricity consumption at specific times.

True. This is what DDRs do. [Lecture 11, slide 104 states the DRR definition]

iii. Generally speaking, an EV can act as either a supply side resource or a demand side resource when its battery has a s.o.c. in the 50-70 % range.

False. An EV can act either as a supply-side resource or a demand-side resource when its battery is in the 60 – 80 % s.o.c. range. [Lecture 11, slide 44]

iv. We compare the emissions of two EVs with distinct efficiencies to drive concurrently an identical trip. During the drive of this trip, the more efficient EV emits less GHG emissions than the less efficient EV, independent of the primary sources of the electricity used to charge the EVs.

False. The only case when the efficiency makes no difference is when both EVs are charged with 0-*GHG* electricity. Otherwise, the more efficient EV consumes less electricity over the trip distance and so for electricity that is not 0-*GHG*, the greater consumption entails larger emissions.