EE331 Fall 2019 HW 1

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Q1: Find the phasor current I_S

```
v = {'S': 120}

z = {
    'M': 10 + 4j,
    'S': 0.2 + 0.5j,
    'L': 0.3 + 0.1j,
    'X': 3 + 10j
}

z['LM'] = z['L']+z['M']
z['LMX'] = (z['LM']**-1 + z['X']**-1)**-1
z['equivalent'] = z['LMX'] + z['S']

i = {'S': v['S']/z['equivalent']}
print("\(\\boxed{I_S =", f"{i['S']:.3}", "\si{A}}\)")
```

$\boxed{I_S = (11.9 - 14.2j)\text{A}}$

Q2: Find the phasor voltage V_X

$$\frac{V_S - V_X}{Z_S} = I_S$$
$$\implies V_X = V_S - Z_S I_S$$

```
v['X'] = v['S'] - i['S']*z['S']
print("\(\\boxed{V_X =", f"{v['X']:.3}", "\si{V}}\)")
```

$\boxed{V_X = (111 - 3.12j)\text{V}}$

Q3: Find active power, reactive power, and apparent power flows at point X

```
p = {'X': v['X']*i['S']}
p['apparent'] = abs(p['X'])
p['active'] = p['X'].real
p['reactive'] = p['X'].imag
print(f"Active Power @ X = {p['active']:.5} W")
print(f"Reactive Power @ X = {p['reactive']:.5} VAR")
print(f"Apparent Power @ X = {p['apparent']:.5} VA")
```

```
Active Power @ X = 1272.7 W
Reactive Power @ X = -1604.0 VAR
Apparent Power @ X = 2047.5 VA
```

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```python
import numpy
import pint
unit = pint.UnitRegistry()

w = 60.0 * 2*numpy.pi * unit.rad/unit.s
v = {'S': 120 * unit.volts, 'L': 110*numpy.exp(1j * numpy.radians(5)) * unit.volts}
l = {'S': 0.1 * unit.mH, 'L': 0.2 * unit.mH}
r = {'S': 0.3 * unit.ohm, 'L': 0.5 * unit.ohm}
z = {'S': r['S'] + w*l['S']*1j, 'L': r['L'] + w*l['L']*1j}
```

Q1: Find the phasor current I_S

$$I_S = \frac{V_S - V_L}{Z_{equivalent}}$$

```python
z['equivalent'] = z['S'] + z['L']
i = {'S': (v['S']-v['L'])/z['equivalent']}
print("\(\\boxed{I_S =", f"{i['S'].magnitude:.3}", "\si{A}}\)")
```

$\boxed{I_S = (11.1 - 13.6j)\text{A}}$

Q2: Find active power, reactive power, and apparent power flows at load V_L

$$P_L = I_S V_L$$

```python
p = {'L': i['S']*v['L']}
p['active'] = p['L'].real
p['reactive'] = p['L'].imag
p['apparent'] = abs(p['L'])
print(f"Active Power @ X = {p['active'].magnitude:.5} W")
print(f"Reactive Power @ X = {p['reactive'].magnitude:.5} VAR")
print(f"Apparent Power @ X = {p['apparent'].magnitude:.5} VA")
```

```
Active Power @ X = 1347.1 W
Reactive Power @ X = -1378.8 VAR
Apparent Power @ X = 1927.6 VA
```

Q3: Monthly cost for operating load. Assume that one month has 30 days.

$$C_m = \frac{20\ \text{cents}}{\text{kWh}} \cdot \frac{30 \cdot 24\ \text{h}}{\text{month}} \cdot P_{L\_active} \times 10^{-3}\text{kWh}$$

```python
centsPerkWh = 20
daysPerMonth = 30
hoursPerDay = 24
hoursPerMonth = daysPerMonth * hoursPerDay
monthlyDollars = centsPerkWh * hoursPerMonth * p['active'].magnitude /10**3 / 100
print(f"Cost (dollars): {monthlyDollars:.5}")
```

```
Cost (dollars): 193.98
```