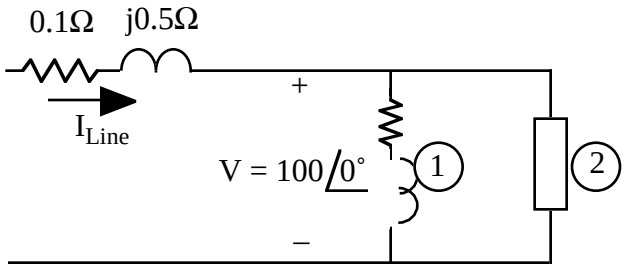
Required Homework Problem 1
Average Power and Power Factor with Periodic Waveforms

a) Power factor and fundamental and total rms - Two loads are connected in parallel to a voltage source V = 100 V rms that can be considered to have a constant amplitude and sinusoidal waveform (i.e, the source impedance can be neglected). The loads are:

Load 1 - Linear, 1000 watts at 0.70 power factor lag , fundamental component only

Load 2 - Nonlinear, 1000 watts at 0.95 displacement PF lag and 0.80 distortion PF.

Find:



Fund rms current in Load 2 = _____ A

Total rms current in Load 2 = _____ A

Fundamental rms of I_{Line} = _____ A

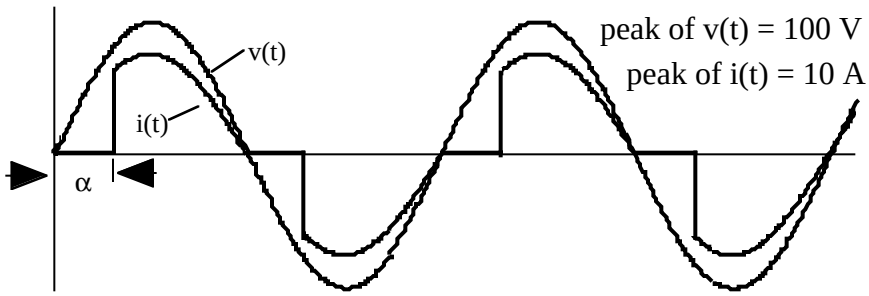
Total rms of I_{Line} _____ A

Combined Displacement PF = _____

Combined Distortion PF = _____

Power loss in the line R = 0.10 ohm = _____ w

b) Fundamental component and average power - Find the fundamental component rms amplitude and phase angle for i(t) using v(t) as the phase reference if α is 50˚. Note that in this case both the sine and cosine terms of the fundamental must be found. Find the average power associated with v(t) and i(t). Except for the blocked portion of i(t), both v(t) and i(t) are sinusoidal.



Fund rms = _____ A

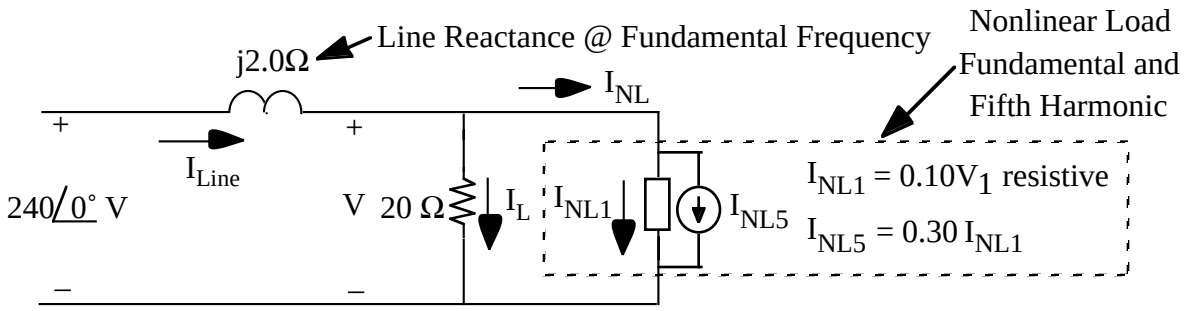
Fund Phase = _____ ˚

P_{avg} = _____ W

c) **Harmonic voltage distortion at point of common coupling (PCC)** - consider the system illustrated in the figure below with a non-linear load having a fifth harmonic. With a 240 V sinusoidal source at the left, the waveform of V at the load would be a sinusoid except for the influence of the nonlinear load. Any harmonic voltage at this PCC will cause harmonics in any other connected linear loads and should be minimized.

Assuming the nonlinear current i_{NL} can be represented as a resistor for the fundamental and a current source for the fifth harmonic, find (make multiple use of superposition)

1) the fundamental voltage $V = V_1$ and fifth harmonic voltage $V = V_5$ at the load
2) the rms value of the voltage $V = V_{rms}$ at the load
3) the fifth harmonic current and power in the 20Ω load resistor
4) the fifth harmonic line current supplied by the 240 V source.
5) the fifth harmonic voltage $V = V_5$ at the load if the line reactance is 1.0 Ω instead of 2.0 Ω.



V_1 = _____ V rms

V_5 = _____ V rms

V_{rms} = _____ V rms

I_{L5} = _____ A rms

P_{L5} = _____ w

I_{line5} = _____ A

$V_{5(x=2)}$ = _____ V rms