I. (20 pts) Calculate the average (i.e., effective) value of the signal shown below

\[ F = 4 \text{ mV} \]

\[ \text{Value} = \sqrt{\frac{1}{4mV} \left[ \sum_{0}^{1mV} 2^2 + \sum_{1mV}^{2mV} 1^2 + \sum_{2mV}^{3mV} (-1)^2 + \sum_{3mV}^{4mV} (-3)^2 \right]} \]

\[ = \sqrt{\frac{1}{4}} \times 15 = \frac{15}{2} = 1.94 \text{ A} \]
II. (30 pts) In the circuit below, what is the value of the resistor $R$ that will cause the rms voltage across the two inductors to be equal? What is the value of that rms voltage?

\[ Z_{eq} = R / \left( 0.3 \angle 0 \right) = j0.3R \frac{Z_{eq}}{R + j0.3Rw} \]

\[ V_{\text{rms1}} = \left| 120 \angle 0 \right| = \frac{j0.1w}{j0.1w + Z_{eq}} = 120 \angle 0 = \frac{0.03w + j0.1wR}{-0.03w^2 + j0.1wR} \]

\[ V_{\text{rms2}} = \left| 120 \angle 0 \right| = \frac{j0.3Rw}{R + j0.3Rw} = \frac{j36Rw}{-0.03w^2 + j0.4wR} \]

Such that

\[ |j36Rw| = |120(-0.03w^2 + j0.1wR)| \]

\[ 36Rw = \sqrt{12.96w^4 + 144w^2R^2} \]

\[ R = 0.1061w = 40.52 \text{ Ohms} \]
III. (25 pts) Find the power factor at which the source voltage $V_s$ is operating? What is the average power supplied by the source?

\[ V_s = 120 \angle 0^\circ \text{ V rms} \]

\[ f = 60 \text{ Hz} \]

\[ I_s = \frac{120}{\left(4 + \frac{192}{12 + j16}\right)} = 9.214 \text{ A rms} \]

\[ \therefore PF_s = 0.8969 \text{ lag} \]

\[ P_s = V_s I_s \text{ eff} PF_s \]

\[ P_s = 120 (9.214) (0.8969) = 991.7 \text{ W} \]
IV. (25 pts) In the circuit below, find the complex power absorbed by the 20 Ω resistor.

\[ V_{\text{eff}} = 100 \angle 0^\circ \]
\[ I_{\text{eff}} = \frac{100}{60 + 10j} = 1.622 - 0.277j \]
\[ I_{20\Omega} = \frac{60}{20 + j20} \cdot (1.622 - j0.277) \]
\[ = 0.945 + j0.675 \]
\[ S_{20\Omega} = V_{\text{eff}} \cdot I_{20\Omega} = 20 \left( 0.945^2 + 0.675^2 \right)^{1/2} \angle 0^\circ \]
\[ = 20 \sqrt{0.893 + 0.4586} \angle 0^\circ \]

\[ S = 23.23 \angle 0^\circ \text{ VA} \]
IV. (25 pts) In the circuit below, find the complex power absorbed by the 20 \Omega resistor.

\[
\begin{align*}
\text{20}\angle 0^\circ &= 50 + \frac{20}{20 + 20} = 50 + \frac{20}{2(1 + j)} = 50 + 10j(1 - j) \\
V_{\text{eff}} &= \frac{100}{60 + 10j} \\
I_{\text{eff}} &= \frac{100}{60 + 10j} = 1.622 - 0.27j \\
I_{20} &= \frac{10}{20} \left( 1.622 - j0.27 \right) \\
&= 0.945 + j0.675 \\
S_{20 - 2} &= V_{\text{eff}} I_{20} = R I_{20} I_{20} \\
\text{real} \rightarrow S_{20 - 2} &= 20 \sqrt{(0.945)^2 + (0.675)^2} \angle 0^\circ \\
&= 20 \sqrt{0.893 + 0.4556} \\
S_{20 - 2} &= 23.23 \angle 0^\circ \text{ VA}
\end{align*}
\]