Problem 1. Carefully sketch each of the following three waveforms on the graph provided.

\[ 10\cos(\omega t - 90^\circ), \ 5\cos(\omega t + 30^\circ), \ 8\cos(\omega t + 45^\circ) \]
Problem 2. Use phasors to combine the following three cosine voltages given into a single cosine and obtain magnitude $A$ and phase angle $B$ (in degrees).

$$A \cos(\omega t + B^\circ) = 10 \cos(\omega t + 30^\circ) + 15 \cos(\omega t - 50^\circ) - 20 \cos(\omega t + 120^\circ)$$
Problem 3. The three waveforms shown have the same frequency. Express each in phasor form. Add the three and determine the sum in phasor form (one magnitude, one angle). Plot the sum phasor on this graph.
Problem 4. Solve for the phasor current flowing through the inductor.
Problem 5.

Given the single-phase circuit shown above. The voltage across Load 2 is 120Vrms and has phase angle = 0º.

- Compute the currents flowing into Load 2 and Load 1 (rms magnitudes and phase angles)
- Compute the source current (rms magnitude and phase angle)
- Compute the source voltage (rms magnitude and phase angle)
- Compute the P and Q provided by the source
- Compute the efficiency of the system, i.e., Load P / Source P.
Problem 6. A three phase, 480V-rated motor delivers 10kW to a pump. Motor efficiency is 0.90. Motor power factor is 0.85. An electrician measures the line-to-line voltage at the motor, and the reading is 460Vrms. The electrician then reads the amperes in one of the three a-b-c wires feeding the motor.

a. What reading can the electrician expect to see?

b. Phase a-b-c wires connecting the motor to a power panel each have 0.1 resistive ohms per phase, and negligible inductance. If the electrician reads the line-to-neutral voltage at the power panel, what reading can the electrician expect to see?
Problem 7. Open circuited capacitors gradually lose their stored energy. This internal loss is modeled as an equivalent parallel resistance. Assume that a 4700µF capacitor has an equivalent parallel resistance of 2MΩ. If the capacitor is initially charged to 100V, how long will it take for the voltage to drop to 50V?
**Problem 8.** A 12V battery is suddenly connected to an inductor L. The current that flows is shown in the graph. Determine L and the net series resistance R. R includes the resistance of the battery, inductor, and wiring.
Problem 9. Write the three KCL equations and one dependent source equation needed to solve for node voltages $V_1$, $V_2$, and $V_3$. Do not combine terms or fractions. Do not solve. After writing the equations, gather the terms and put them into the matrix cells provided. Do not combine terms or fractions in the matrix.
Problem 9, cont.

\[
\begin{array}{ccc|c}
 & & & V_1 \\
 & & & = \\
 & & & V_2 \\
 & & & = \\
 & & & V_3 \\
\end{array}
\]
Problem 10. Using the circuit from Problem 4, and assuming that $V_S$ is a sinusoidal source,
a. Determine expressions for complex transfer functions $V_C/V_S$ and $V_L/V_S$.

b. Sketch Bode plots for the magnitude and phase angles of $V_C$ and $V_L$ over the range
$1 \text{ Hz} \leq f \leq 100 \text{kHz}$. Use log10 scale for frequency (Hz). Use dB for voltage magnitudes, and
degrees for phase angles.

c. Produce separate but exact Excel plots using the actual complex transfer functions. On
the x-axes, use ten equally-spaced (in log10) points per decade.