Today we will investigate the operation and performance of a three-phase rectifier connected to a resistive load then an RL-load. Data will be collected for different firing angles and then used to assess our derived governing equations.

**Part 1: Resistive Load**

1. Confirm that the variable voltage control knob is set to zero. Connect the variable voltage power supply terminals to the three-phase thyristor bridge as shown in the figure below while incorporating the power analyzer to measure 3-phase power. Choose any configuration you wish (2 wattmeter method, 3-wire, etc.).

2. Both switches on the Thyristor Unit should be closed (1) so that the thyristors in each leg are connected and the three legs are connected at the top and bottom.

3. Connect the DC-side load as shown below \( (R_p = 300\Omega \| 600\Omega \| 1200\Omega) \). This is two phases of the resistor bank. With the Fluke, measure the load resistance \( (R_p \| R_p) \) before inserting: ______________
4. Note, two legs of the 3-phase resistance module are being used to implement the load. Use the clamp on current sensor and connect to CH1 of the oscilloscope. Connect the output of the voltage isolator to CH2 of the oscilloscope. The Fluke ammeter should be set to measure the total rms current (ac+dc).

5. Couple the 9-pin connector between the thyristor firing unit and the thyristor module. Connect the +24V power cable between the main power supply and the thyristor module.

6. Connect terminals 4 and 5 of the main power supply to the sync inputs of the thyristor firing unit. These are the synchronizing signals required to properly gate the thyristors.

7. On the thyristor firing unit, connect the DC Source to the Angle Control Input with the small white wire provided.

8. Make the following settings on the thyristor firing unit:

   Complement 0
   Arc cosine 0
   DC Source min (fully counter-clockwise)
   Three-Phase

9. **Have the instructor verify your setup:** ________________

10. Verify that the power supply for the current/voltage isolators and thyristor firing unit is plugged into a 120VAC outlet. Energize it.

11. Energize the +24V supply on the main power supply.

12. Energize the main power supply. Dial the variable voltage control knob to provide approximately 70.71Vrms as the input line voltage (as read by the power analyzer).

13. Obtain a stable image on the oscilloscope. Trigger on AC Line and use ACQUIRE-AVERAGE to smooth the waveforms. If the output voltage on the oscilloscope does not look like a rectifier output, call the instructor over (the sync inputs may need to be flipped). Adjust the horizontal control so that three periods are displayed.

14. Complete the following table for \( \alpha = 0^\circ, 15^\circ, 30^\circ, 45^\circ, 60^\circ, 75^\circ, 90^\circ \). Note the firing angle is adjusted by turning the DC Source control knob on the thyristor firing unit.

   - The three-phase real power into the rectifier, \( P_{3\text{-Phase}} \), is simply the sum of \( P_{CH1} \) and \( P_{CH2} \) (which is available on the analyzer).

   - The total rms load current, \( I_{\text{Load, rms}} \), is measured with the scope.

   - The DC load current, \( I_{\text{Load, DC}} \), is measured with the Fluke set to DC.
15. From your data, compute the three-phase apparent power, the power factor into the rectifier, the average load voltage, load real power and the rectifier efficiency (Note, you measured $R_{load}$ earlier)

\[ S_{3-Phase} = \sqrt{3} V_{CH1} I_{CH1} \]

\[ pf = \frac{P_{3-Phase}}{S_{3-Phase}} \]

\[ V_{Load,DC} = R_{load} I_{Load,DC} \]

\[ P_{Load} = I_{Load,rms}^2 R_{Load} \]

\[ \eta = \frac{P_{Load}}{P_{3-Phase}} \times 100 \% \]
16. On the same set of axes below, sketch the load current for $\alpha = 60^\circ$ and $\alpha = 90^\circ$ (show three cycles, note the Amps/div and sec/div)

17. Set the firing angle to zero. Dial the main supply variable voltage control knob down to zero. De-energize the main power supply and the +24V power supply.

**Part 2: RL-Load**

1. Modify the load to incorporate ~0.2H of smoothing inductance as shown in the following diagram. Before inserting, measure the inductor resistance: __________ inductance: __________ (LC meter)
2. Have the instructor verify your setup: ________________

3. Energize the +24V supply on the main power supply module.

4. Energize the main power supply. Dial the variable voltage control knob to achieve an input line voltage of approximately 70.71 Vrms (as read by the power analyzer).

5. As before, complete the following data but this time for $\alpha = 0^\circ, 30^\circ, 60^\circ, 90^\circ$. Note, there is one additional column which is the peak-to-peak current ripple of the load. The oscilloscope can measure this for you using the MEASURE button (select the correct CH and specify peak-peak)

<table>
<thead>
<tr>
<th>$\alpha$ (deg)</th>
<th>$V_{CH1}$ (V)</th>
<th>$I_{CH1}$ (A)</th>
<th>$P_{CH1}$ (W)</th>
<th>$P_{CH2}$ (W)</th>
<th>$P_{5-Phase}$ (W)</th>
<th>$I_{Load, rms}$ (A)</th>
<th>$I_{Load, DC}$ (A)</th>
<th>$I_{Load, pk-pk}$ (A)</th>
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6. Complete the following calculations. Note, modify your value of resistance to include the resistance of the inductor.

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<thead>
<tr>
<th>$\alpha$ (deg)</th>
<th>$S_{3-Phase}$ (VA)</th>
<th>$pf$</th>
<th>$V_{Load, DC}$ (V)</th>
<th>$P_{Load}$ (W)</th>
<th>$\eta$ (%)</th>
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7. Sketch the load voltage and current for $\alpha = 60^\circ$ (note the amps/div, volts/div, and sec/div, INDICATE the value of the ripple on the plot)

![Graph](image)

8. Dial the variable voltage control knob down to zero and turn off the main power supply. De-energize the +24V supply. Move the current isolator so that it measures one of the AC line currents (insert it between terminal 4 and where the power analyzer is located, make sure the load is still in the circuit).

**Have the instructor verify your connections:**

9. Re-energize the +24V supply then energize the main power supply. Return the variable voltage control knob back to 70.71Vrms.

10. Obtain a stable scope display for one period of the AC input current for a firing angle of 60 degrees. Sketch on the following set of axes.