

Inst: N. Chowdhury

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1. A half-wave controlled rectifier with a free-wheeling diode is shown in Figure 1. The thyristor, Q is fired at $\alpha = 40^\circ$ during each cycle. The rms value of the source voltage is 120 V. Consider $V_C = 48$ V, $L = 10$ mH and $R = 1.8 \Omega$.

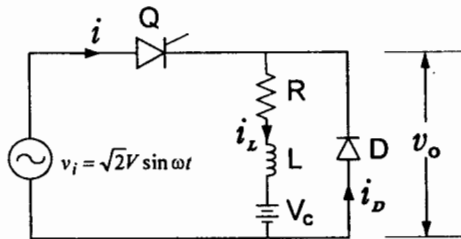


Figure 1: A Half-wave rectifier.

- Sketch to scale the output voltage, the thyristor current, the inductor current and the diode current over one cycle.
 - Obtain a time dependent expression for the output current.
 - Find the average thyristor, inductor and diode currents.
 - Obtain the rms thyristor, inductor and diode currents.
 - Find the maximum reverse voltage across the thyristor.
 - Find the peak values of the currents through the thyristor and the free-wheeling diode.
 - Find the average and rms values of the output voltage.
 - Determine the power output of the converter.
2. A single-phase, full-wave, phase-controlled rectifier supplies an inductive load as shown in Figure 2. For $V = 240$ V, $L = 14$ mH, $R = 2 \Omega$, $V_C = 100$ V and $\alpha = 35^\circ$;
- sketch to scale the time variations of the output voltage and input and output currents.
 - Determine whether the load current is continuous or discontinuous. Calculate the (c) average and rms output current, (d) average and rms output voltage, and (e) the maximum reverse voltage across each thyristor.

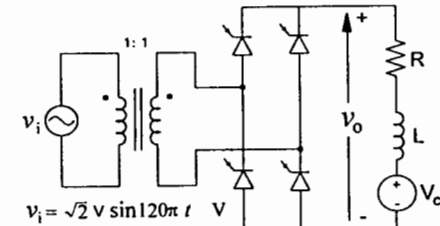


Figure 2: A full-wave controlled rectifier.

3. For the 3-phase half-wave controlled rectifier circuit shown in Figure 3, $V = 120$ V, $R = 3 \Omega$ and $\alpha = 45^\circ$. The load inductance is so large that the load current virtually remains constant. (a) Sketch to scale the time variations of the output voltage, the output current and the input line currents, and calculate the (b) average output voltage, (c) average output current and (d) the maximum reverse voltage across each thyristor.

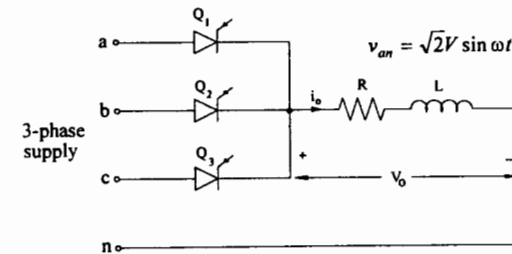


Figure 3: A three-phase half-wave rectifier.

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