RECTIFIER CIRCUITS

POWER SUPPLY BUILDING BLOCKS

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TOPIC OUTLINE

Half-Wave Rectifier

Full-Wave Center-Tapped Rectifier

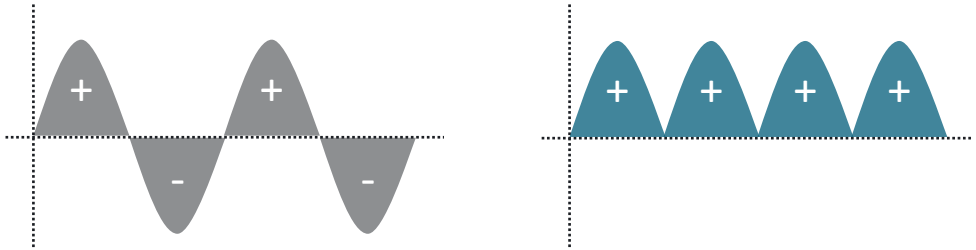
Full-Wave Bridge-Type Rectifier

HALF-WAVE RECTIFIER

RECTIFIER

A **rectifier** is an electronic device or circuit that converts alternating current (AC) to **direct current** (DC). This process is called rectification.

Power Supply Block Diagram



AVERAGE VALUE OF $f(x)$

$$f(x)_{ave} = \frac{1}{b-a}\int_a^b f(x)dx$$

$$v_{ave} = \frac{1}{\pi - 0}\int_0^{\pi} v_P \sin(\omega t)dt$$

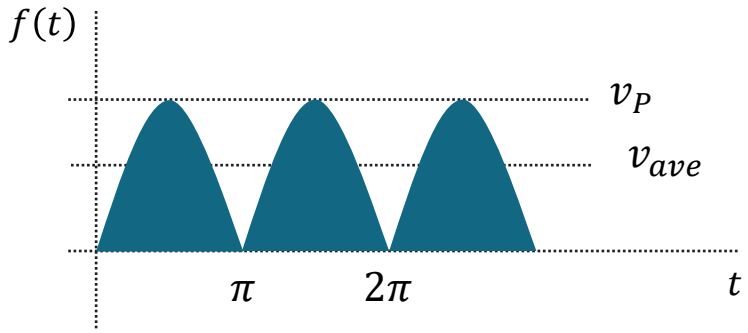
$$v_{ave} = \frac{v_P}{\pi}\left[-\frac{1}{\omega}\cos(\omega t)\right]_0^{\pi} \qquad \text{Let } \omega = 1$$

$$v_{ave} = \frac{v_P}{\pi}[-\cos(\pi) - (-\cos(0))]$$

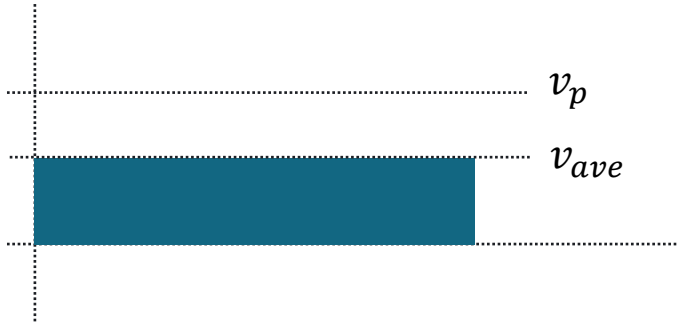
$$v_{ave} = \frac{v_P}{\pi}[-(-1) - (-1)]$$

$$v_{ave} = \frac{2v_P}{\pi}$$

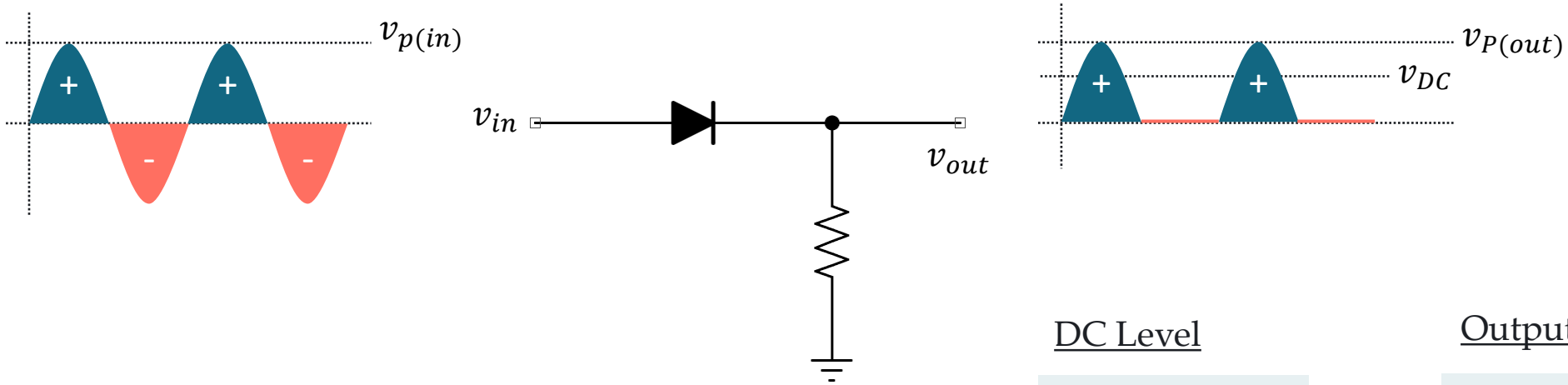
Pulsating DC



DC Level



HALF-WAVE RECTIFIER



DC Level

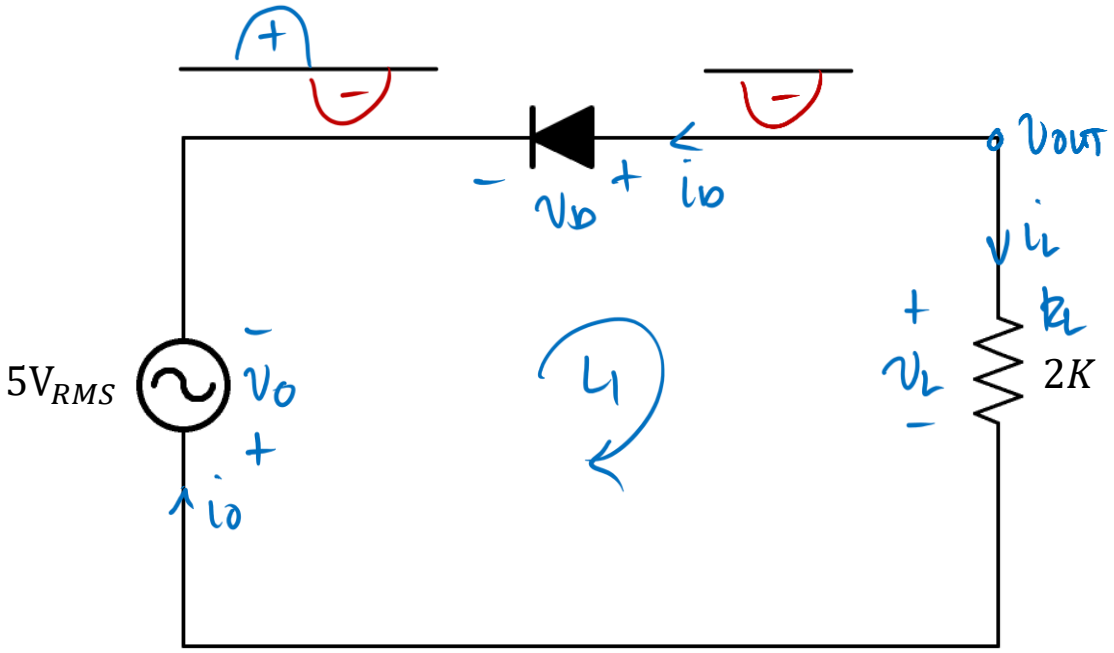
$$v_{DC} = \frac{v_{P(out)}}{\pi}$$

Output Frequency

$$f_{out} = f_{in}$$

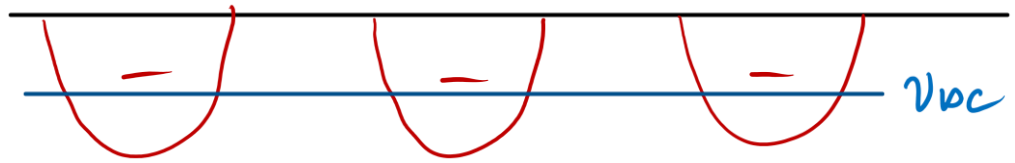
EXERCISE

Sketch the waveform and determine the DC level of the output signal for the given circuit.



Solution

Sketch



$$V_{rms} = \frac{V_p}{\sqrt{2}}$$

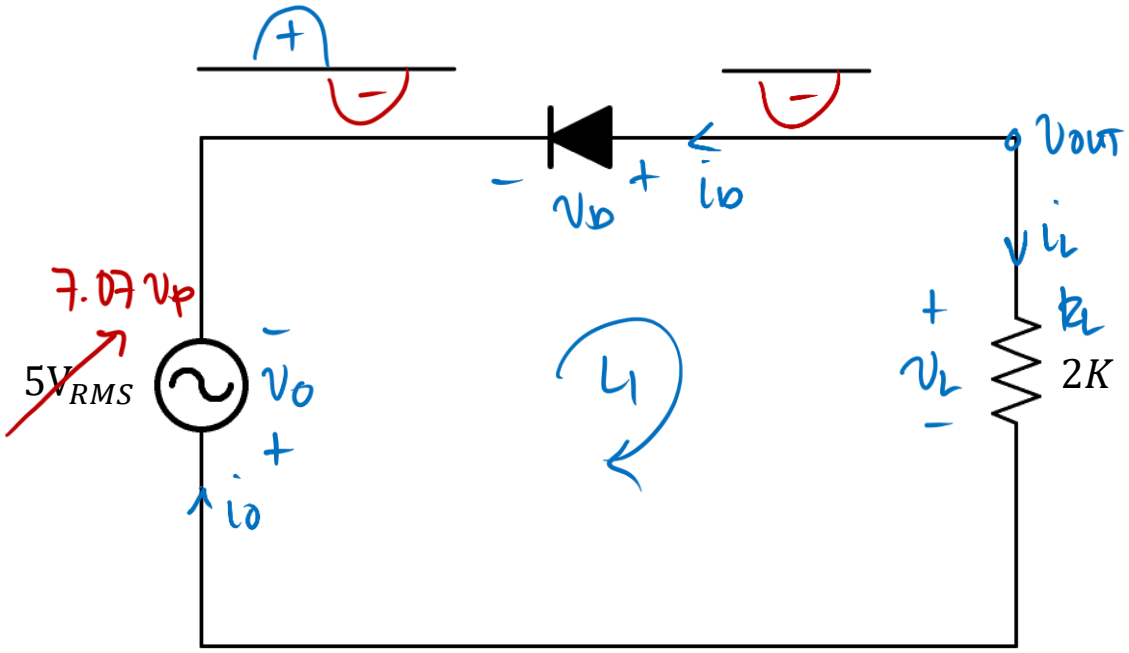
$$V_p = V_{rms}\sqrt{2}$$

$$V_p = 5\sqrt{2}$$

$$V_p = 7.07\,V$$

EXERCISE

Sketch the waveform and determine the DC level of the output signal for the given circuit.



Solution

KVL @ L1

$$v_O - v_D + v_L = 0$$

$$v_L = -v_O + v_D$$

$$v_L = -7.07 + 0.7$$

$$v_{out} = v_L = -6.37\,V_p$$

DC Level

$$V_{DC} = \frac{V_{p(out)}}{\pi}$$

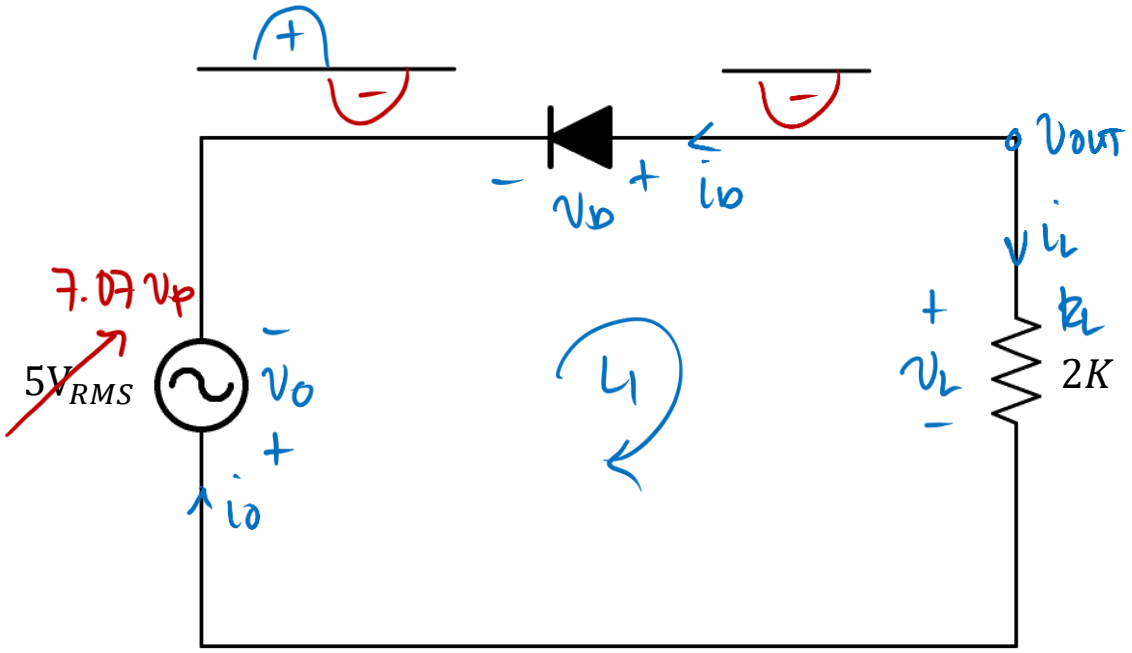
$$V_{DC} = \frac{-6.37}{\pi}$$

$$V_{DC} = -2.03\,V$$

ans

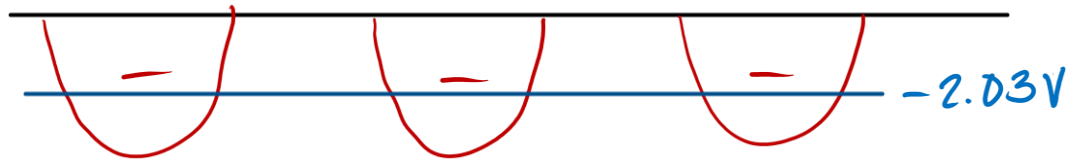
EXERCISE

Sketch the waveform and determine the DC level of the output signal for the given circuit.



Solution

Sketch



DC Level

$$V_{DC} = \frac{V_{P(OUT)}}{\pi}$$

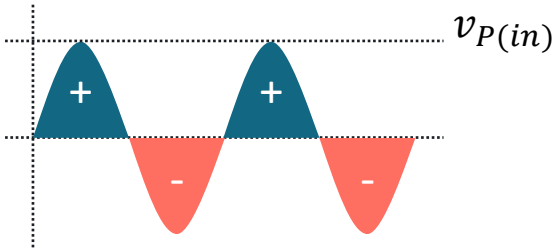
$$V_{DC} = \frac{-6.37}{\pi}$$

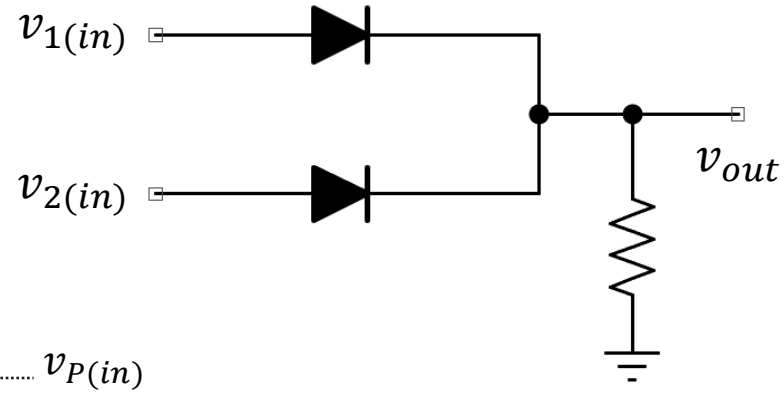
$$\boxed{V_{DC} = -2.03\ V}$$

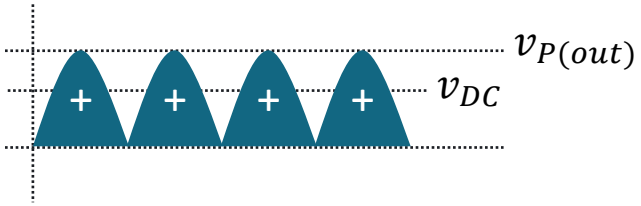
ans

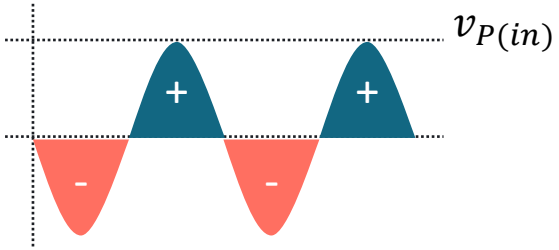
FULL-WAVE CENTER-TAPPED RECTIFIER

FULL-WAVE CENTER-TAPPED RECTIFIER









DC Level

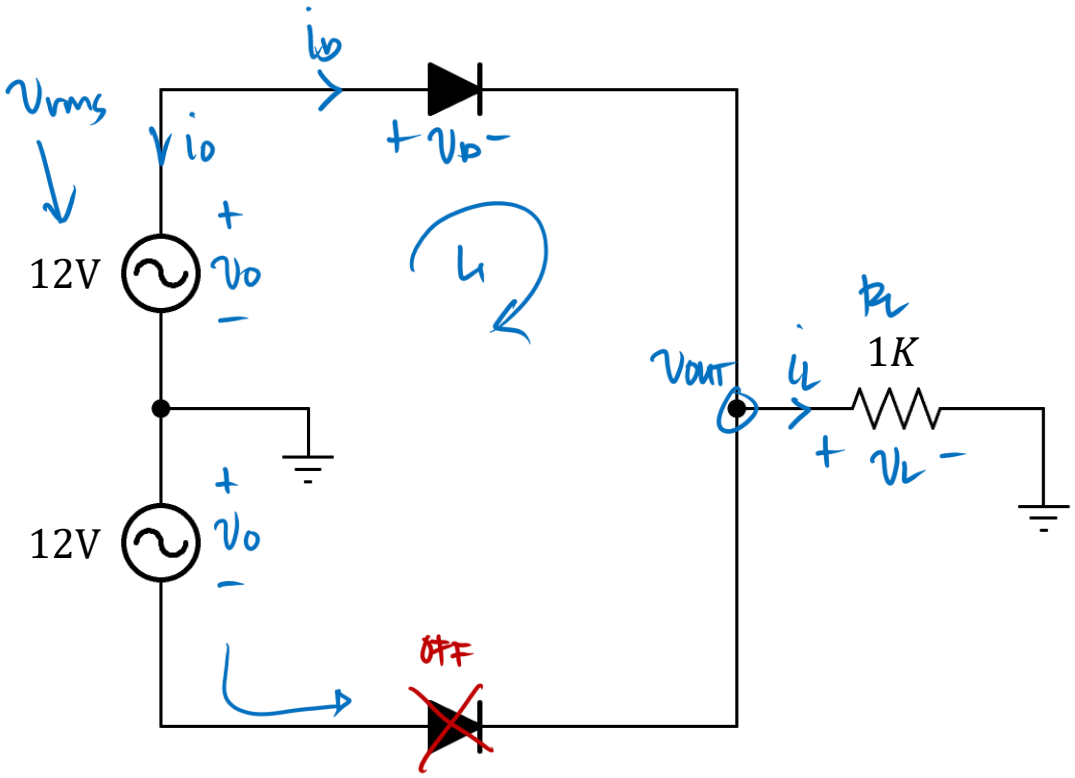
$$v_{DC} = \frac{2v_{P(out)}}{\pi}$$

Output Frequency

$$f_{out} = 2f_{in}$$

EXERCISE

Sketch the waveform and determine the DC level of the output signal for the given circuit.



Solution

$$v_{rms} = \frac{v_p}{\sqrt{2}}$$

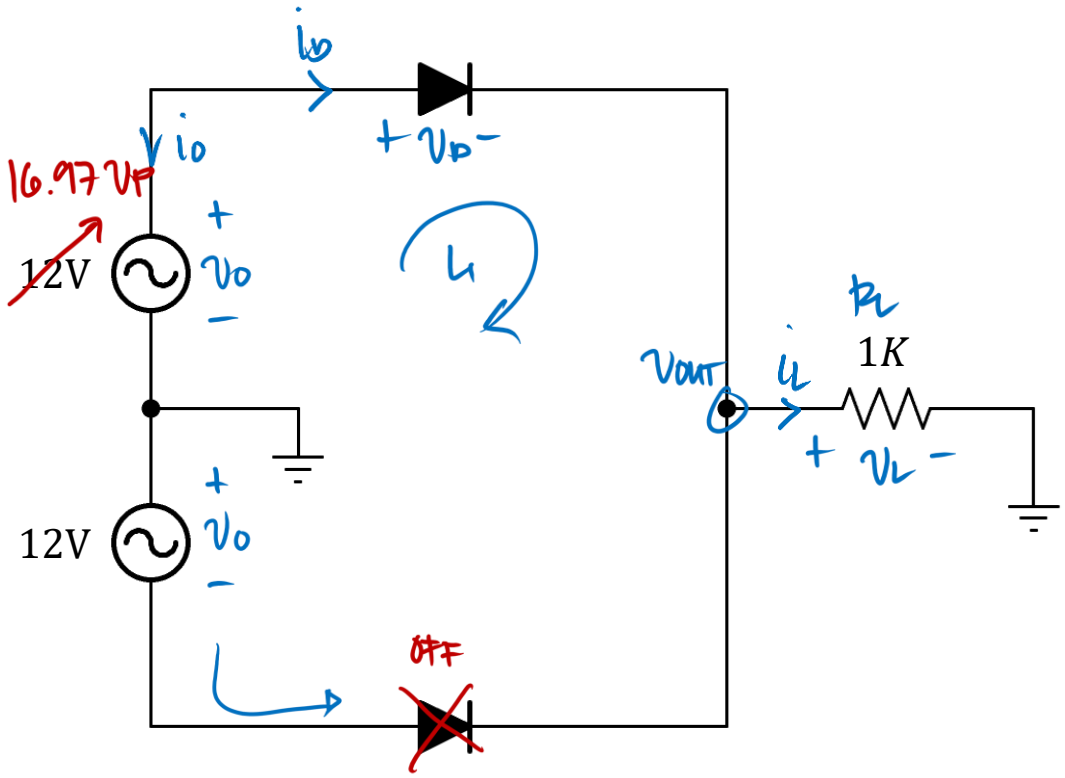
$$v_p = v_{rms}\sqrt{2}$$

$$v_p = 12\sqrt{2}$$

$$v_p = 16.97\ V$$

EXERCISE

Sketch the waveform and determine the DC level of the output signal for the given circuit.



Solution

KVL @ L1

$$-V_D + V_D + V_{OUT} = 0$$

$$V_{OUT} = V_D - V_D$$

$$V_{OUT} = 16.97 - 0.7$$

$$V_{OUT} = 16.27\ V_p$$

$$V_{DC} = \frac{2V_{p(OUT)}}{\pi}$$

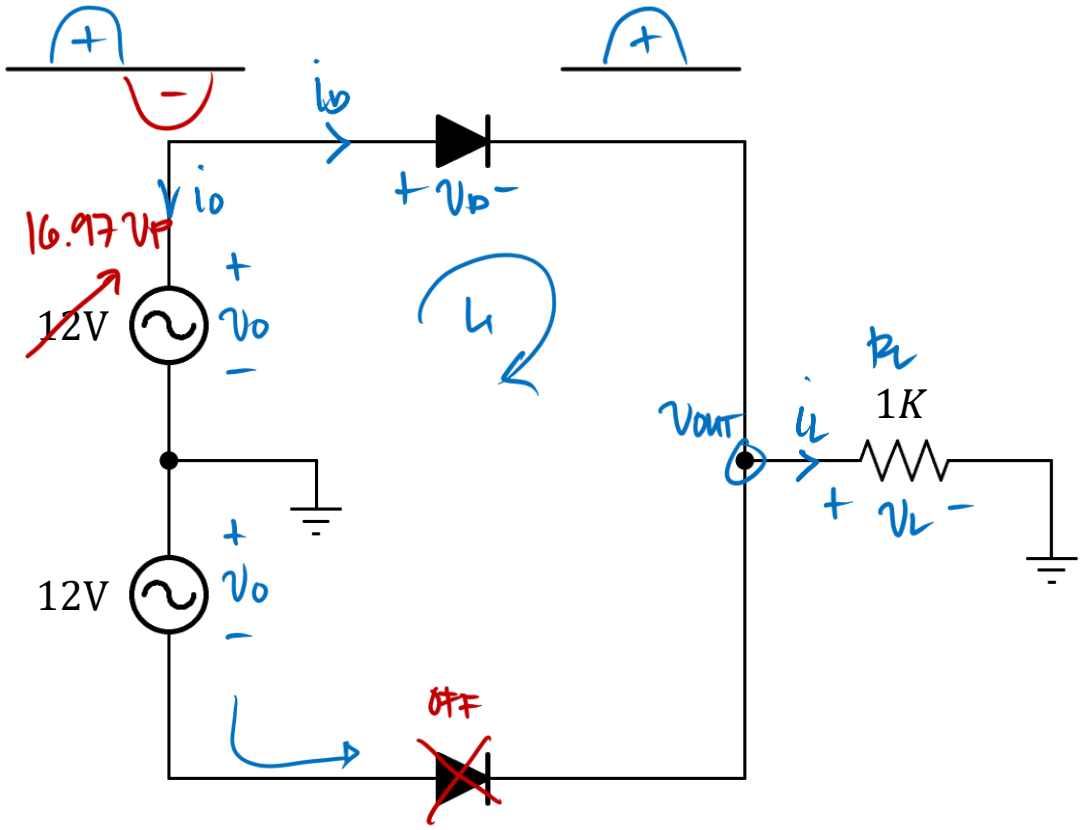
$$V_{DC} = \frac{2(16.27)}{\pi}$$

$$V_{DC} = 10.36\ V$$

ans

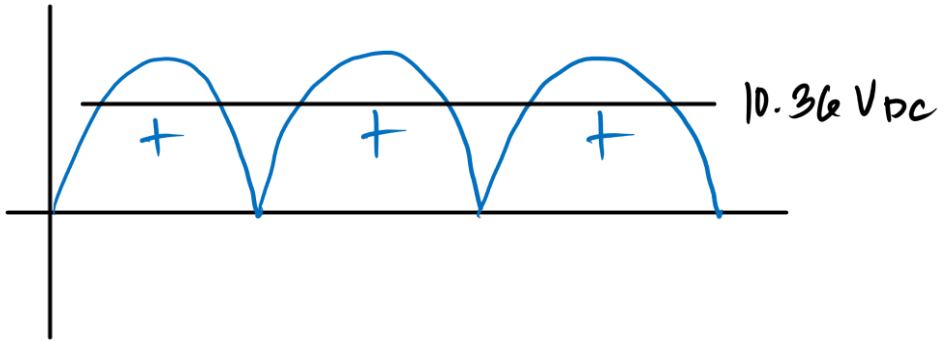
EXERCISE

Sketch the waveform and determine the DC level of the output signal for the given circuit.



Solution

Sketch



$$V_{DC} = \frac{2V_{P(OUT)}}{\pi}$$

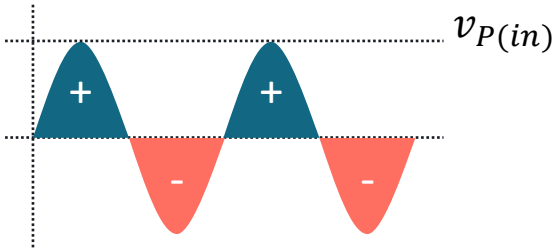
$$V_{DC} = \frac{2(16.27)}{\pi}$$

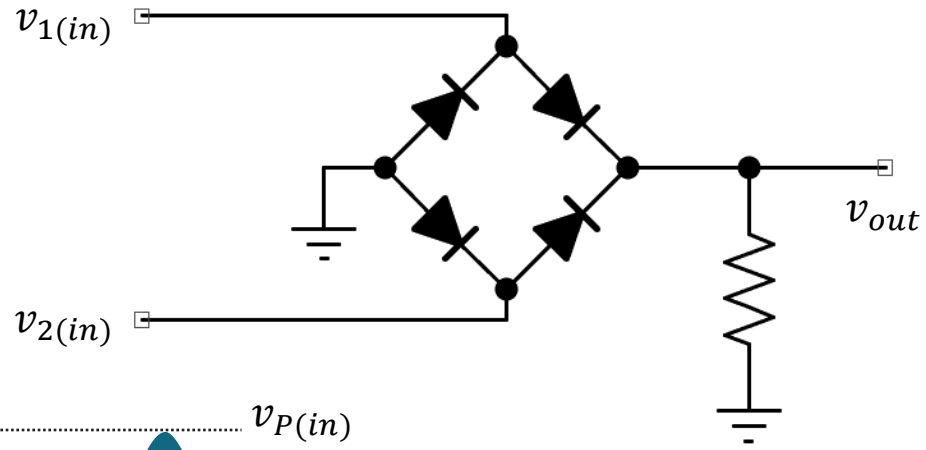
$$V_{DC} = 10.36\ V$$

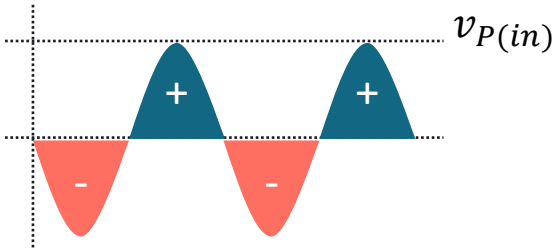
ans

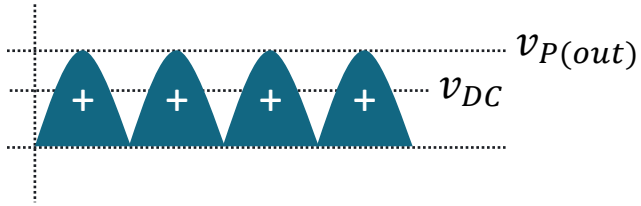
FULL-WAVE BRIDGE-TYPE RECTIFIER

FULL-WAVE BRIDGE-TYPE RECTIFIER









DC Level

$$v_{DC} = \frac{2v_{P(out)}}{\pi}$$

Output Frequency

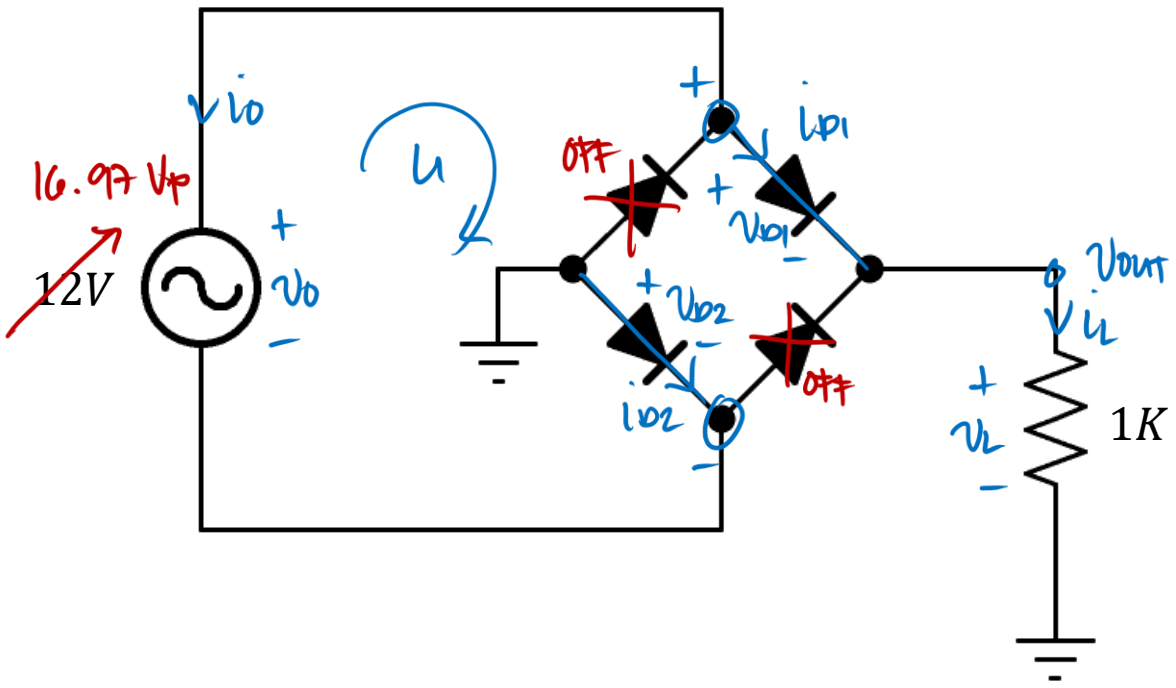
$$f_{out} = 2f_{in}$$

note

Two diodes are ON every half-cycle.

EXERCISE

Sketch the waveform and determine the DC level of the output signal for the given circuit.



Solution

KVL @ L1

$$-v_o + v_{D1} + v_{OUT} + v_{D2} = 0$$

$$v_{OUT} = v_o - v_{D1} - v_{D2}$$

$$v_{OUT} = 16.97 - 0.7 - 0.7$$

$$v_{OUT} = 15.57\ V_p$$

$$v_{DC} = \frac{2\,V_{p(OUT)}}{\pi}$$

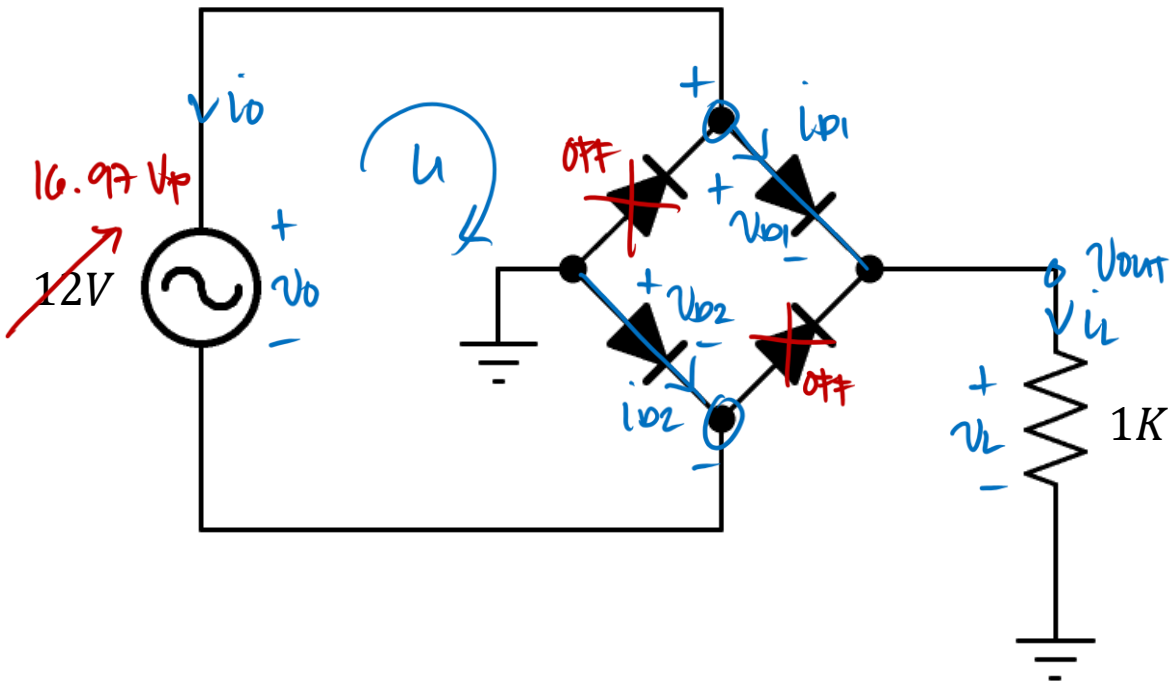
$$v_{DC} = \frac{2(15.57)}{\pi}$$

$$v_{DC} = 9.91\ V$$

ans

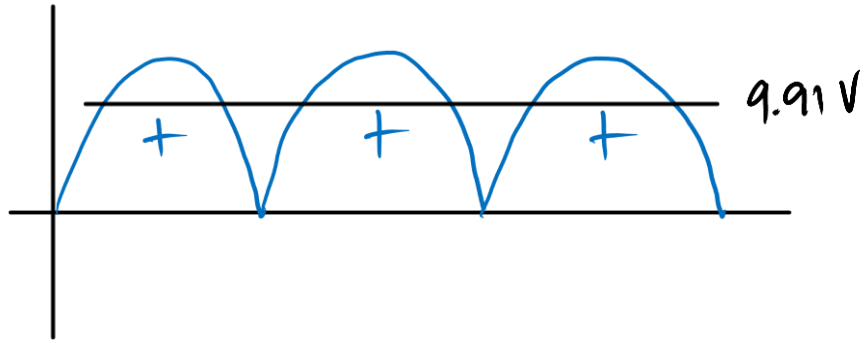
EXERCISE

Sketch the waveform and determine the DC level of the output signal for the given circuit.



Solution

Sketch



$$V_{DC} = \frac{2\,V_{p(out)}}{\pi}$$

$$V_{DC} = \frac{2(15.57)}{\pi}$$

$$\boxed{V_{DC} = 9.91\ V}$$

ans

LABORATORY