Electrical Engineering Fundamentals I Lab

Laboratory 12 Rectifiers and Voltage Regulation

Instructor

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Equipment

- DC Power Supply
- Digital Multimeter
- Waveform Generator
- Digital Oscilloscope
- Devices

Diode: D = 1N4001~1N4007 ×4

Resistors: R = 2 kΩ ×1

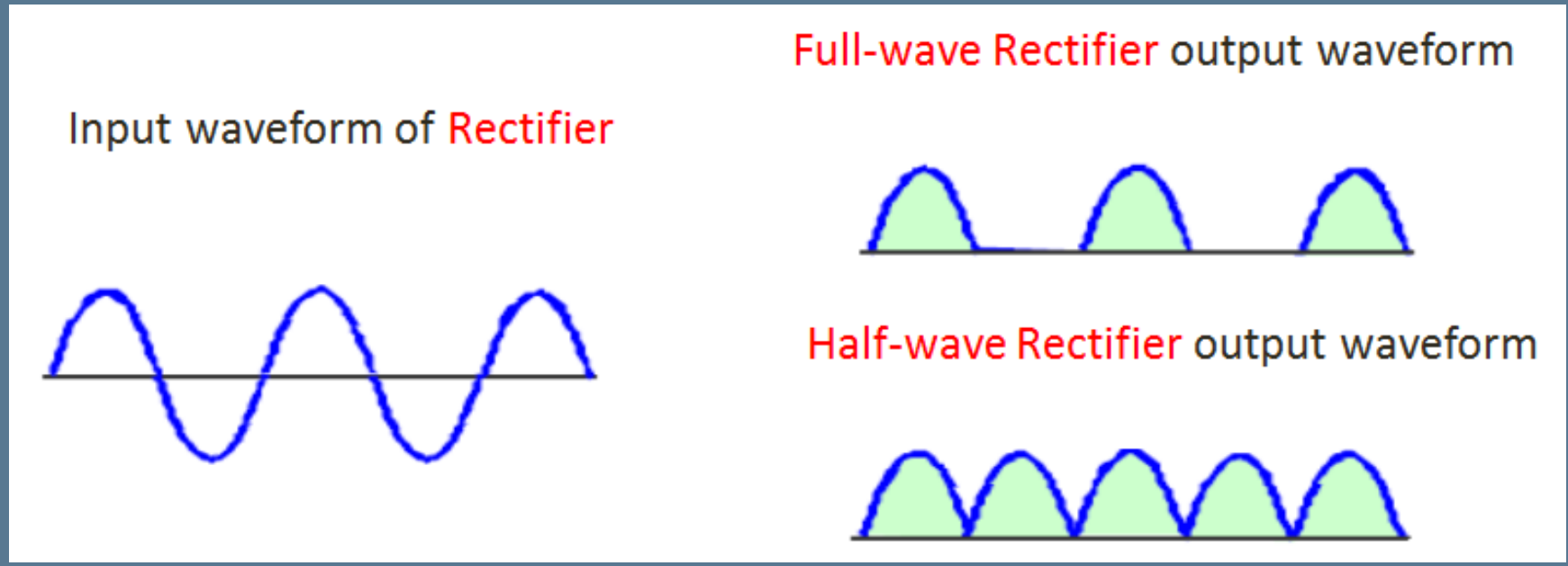
Capacitors: C = 100 μF ×1

Learning Objectives

- Understand the circuit structure and function of the Rectifier circuits.
- Understand the circuit structure and function of the voltage regulation.
- Understand to process to produce a uniform steady voltage from alternating current supply.

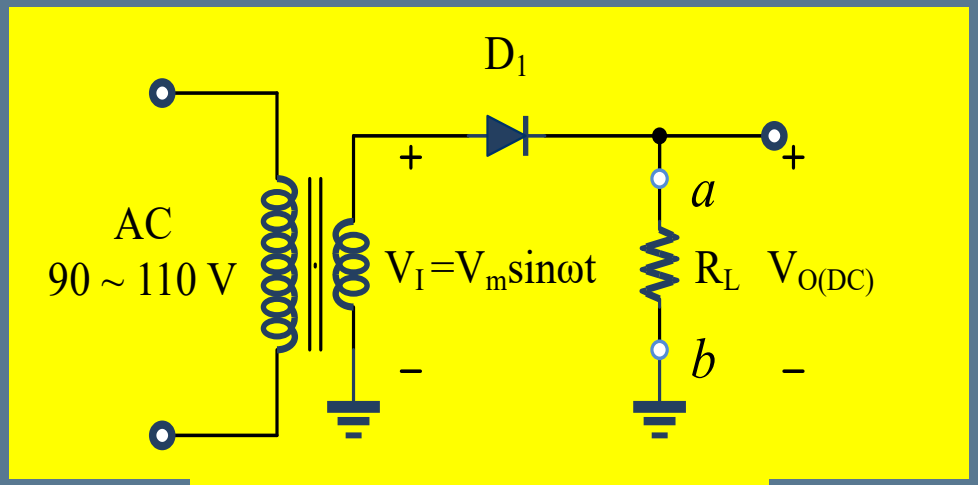
Background

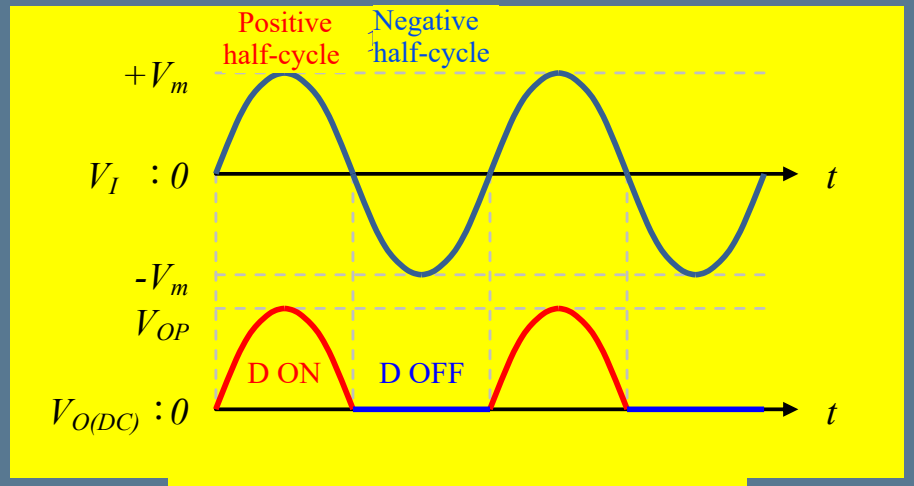
- **Rectifier**
  - The primary application of a diode is for making a Rectifier to convert ac into dc for most electronic devices.

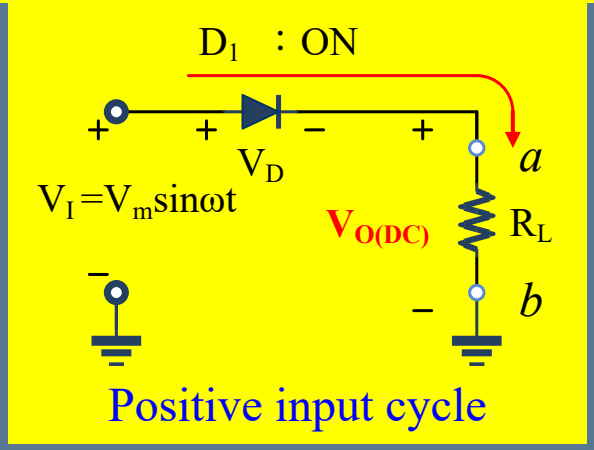


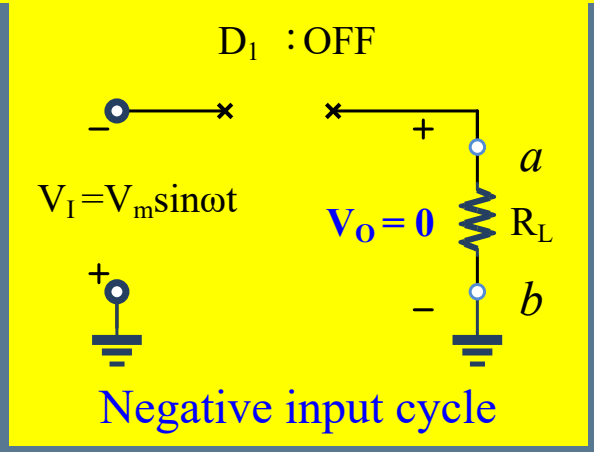
Background

- **Half-wave Rectifier – with single diode**
  - There is only one diode's voltage drop, good for high output V_{DC}



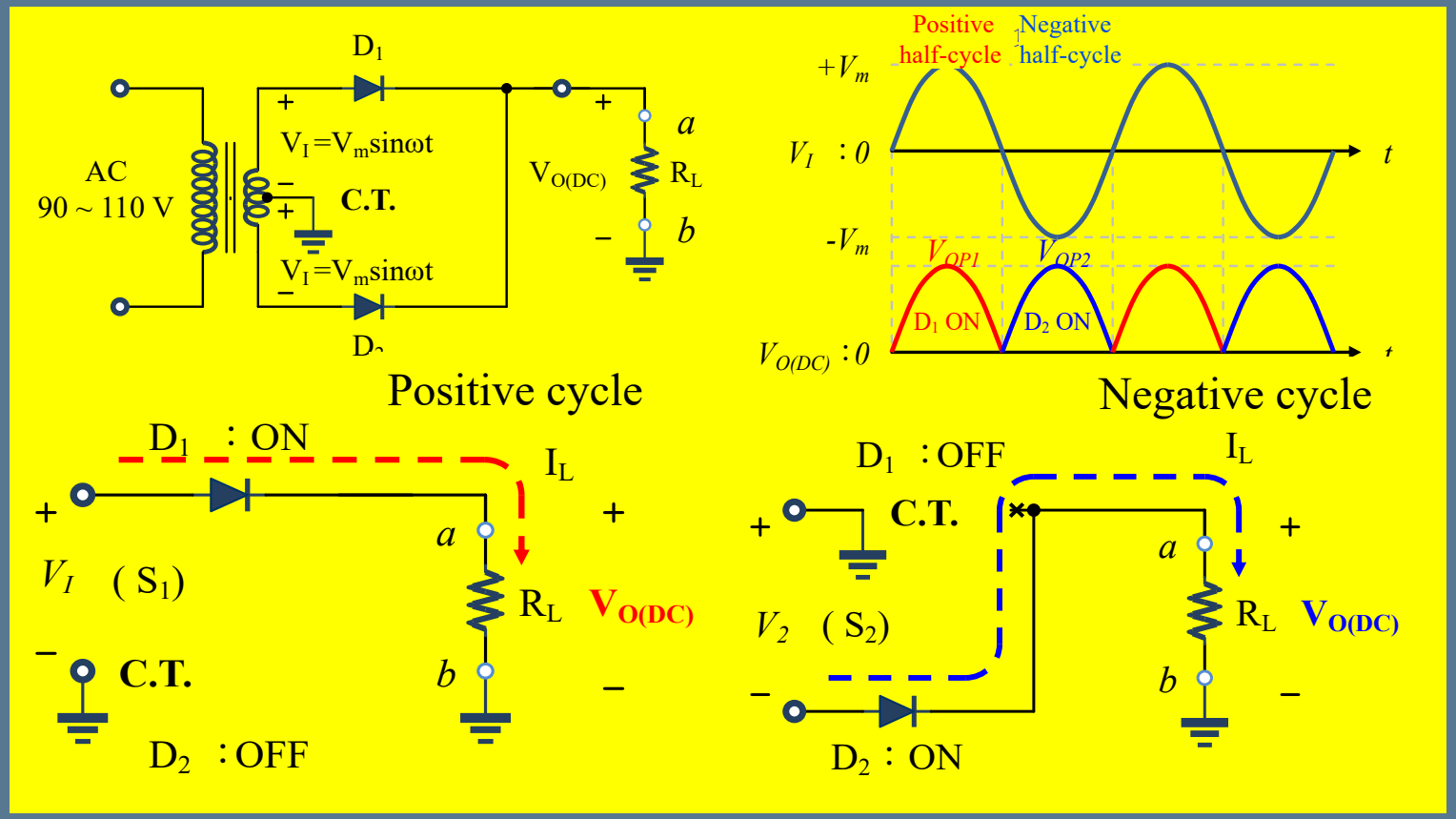






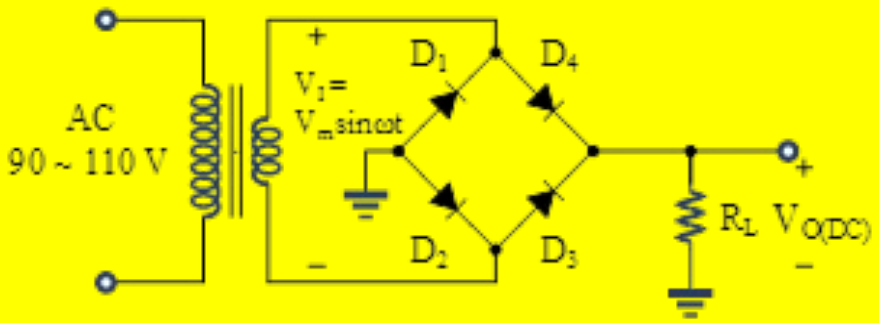
Background

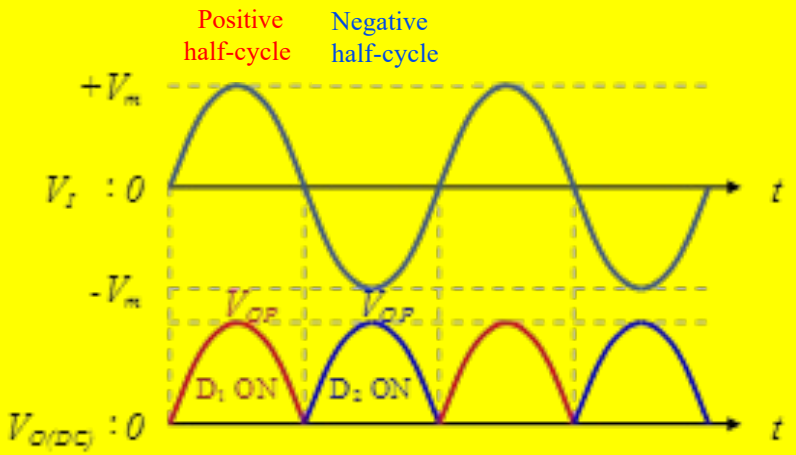
- **Full-wave Rectifier – with dual diode**
  - need a center-tapped transformer



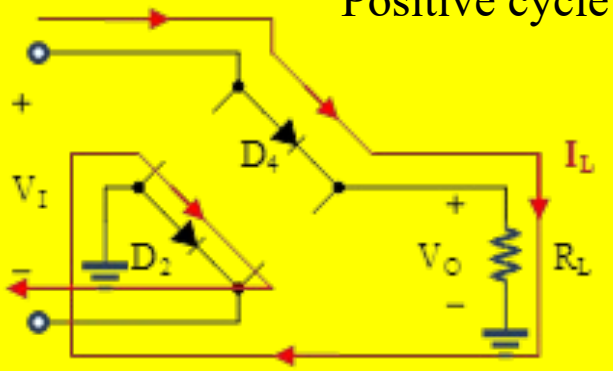
Background

- Full-wave Rectifier – with diode-bridge

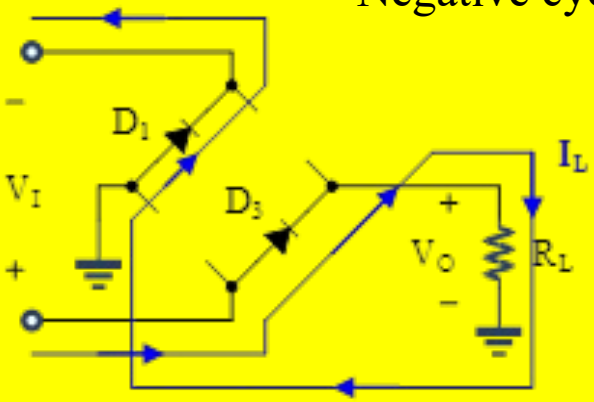




Positive cycle



Negative cycle



Background

Rectifiers Applications

- The primary application of rectifiers is to derive DC power from an AC supply (AC to DC converter). Rectifiers are used inside the power supplies of virtually all electronic equipment. AC/DC power supplies may be broadly divided into linear power supplies and switched-mode power supplies. In such power supplies, the rectifier will be in series following the transformer, and be followed by a smoothing filter and possibly a voltage regulator.
- Rectifiers are also used for detection of amplitude modulated radio signals. The signal may be amplified before detection. If not, a very low voltage drop diode or a diode biased with a fixed voltage must be used. When using a rectifier for demodulation the capacitor and load resistance must be carefully matched: too low a capacitance makes the high frequency carrier pass to the output, and too high makes the capacitor just charge and stay charged.

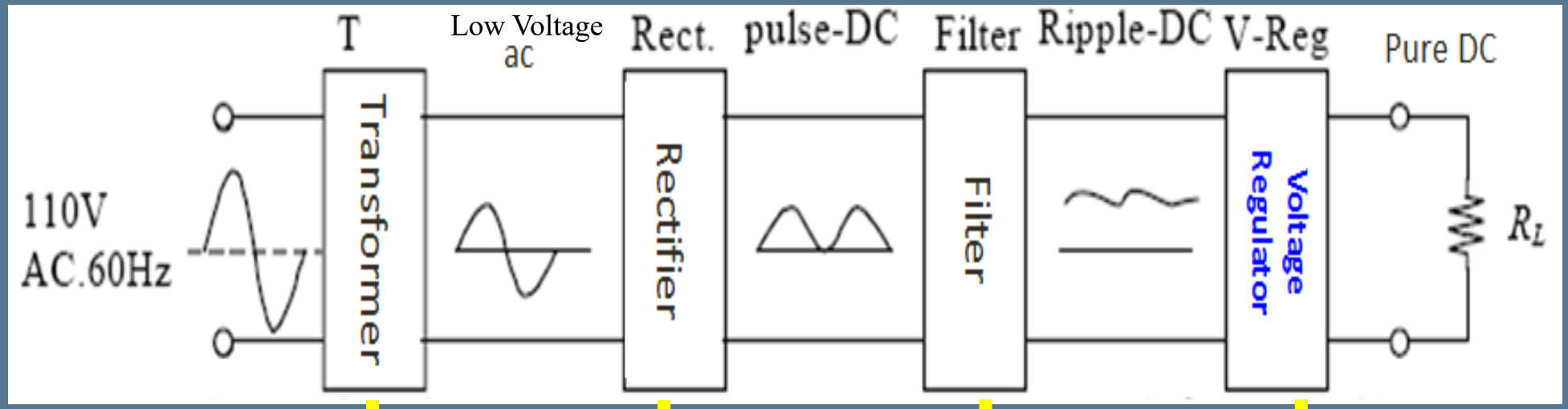
Background

Voltage Regulation

- The voltage regulation is defined as the change in the magnitude of receiving and sending voltage of the transformer.
- The voltage regulation determines the ability of the transformer to provide the constant voltage for variable loads.
- When the transformer is loaded with continuous supply voltage, the terminal voltage of the transformer varies.
- The variation of voltage depends on the load and its power factor.

Background

- Traditional Linear Power Supply



- **Transformer**
  - ✓ Electrical Isolation
  - ✓ Reduced voltage magnitude by winding-ratio
- **Rectifier**
  - ✓ AC to Pulse-DC
- **Filter**
  - ✓ Pulse-DC to Ripple-DC
- **Voltage Regulator**
  - ✓ Reduce Ripple factor of DC level
  - ✓ Variation of load effect is small

Experiments

Experiment 11 Diodes Circuit Applications

- Experiment 11.a Half-wave rectifiers
- Experiment 11.b

  Full-wave Rectifier – with dual diode
- Experiment 11.c

  Full-wave Rectifier with Diode-Bridge

Experiment 11.a Half-wave rectifiers

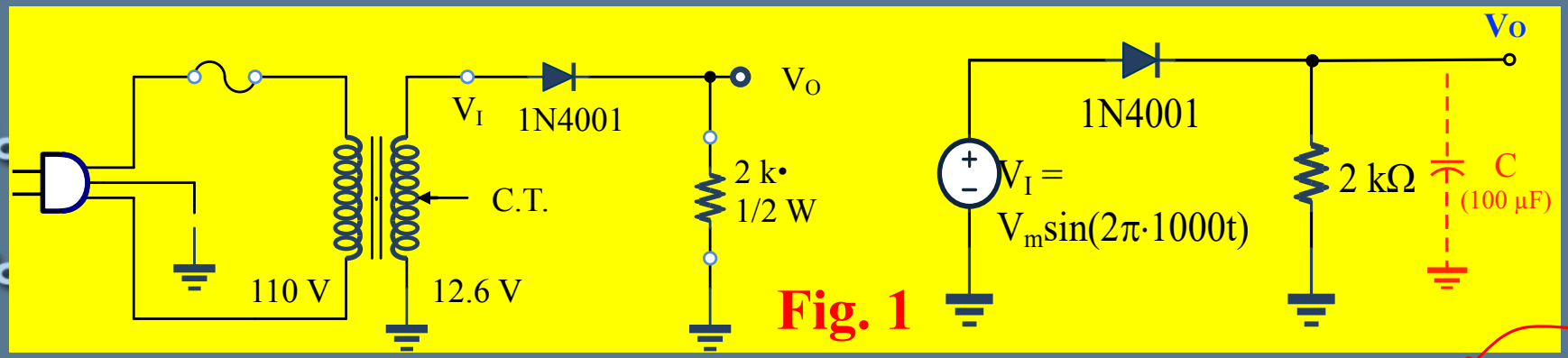
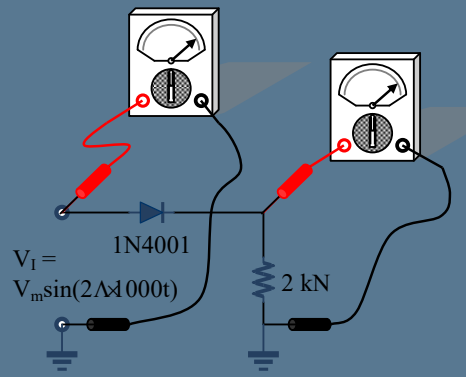
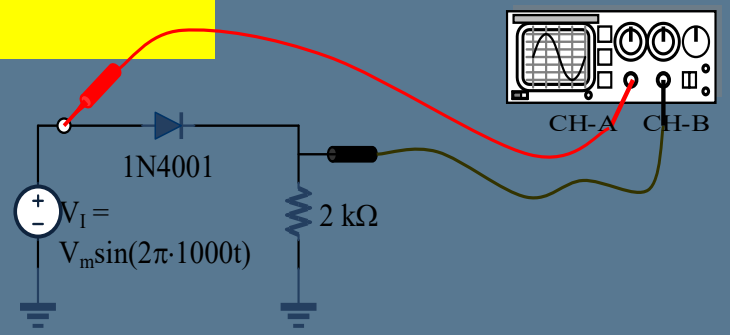


Fig. 1





Steps:

1. Connect the circuit as shown, use any of IN4001～IN4007for the diode.
2. The function generator is used instead of the transformer, set:
   a) $V_{p\text{-}p}$ = 20V, f = 1 kHz sinusoidal waveform,
   b) $V_{p\text{-}p}$ = 5V, f = 1 kHz sinusoidal waveform,
3. Record the input and output waveforms, discuss what you have found from your observation.
4. Measure **V_{DC}** of V_I and V_O by using a digital multi-meter.
5. Repeat step 1～4 for Fig. 1, if **C = 100 μF** is in parallel with the load.

Experiment 11.b Full-wave Rectifier – with dual diode

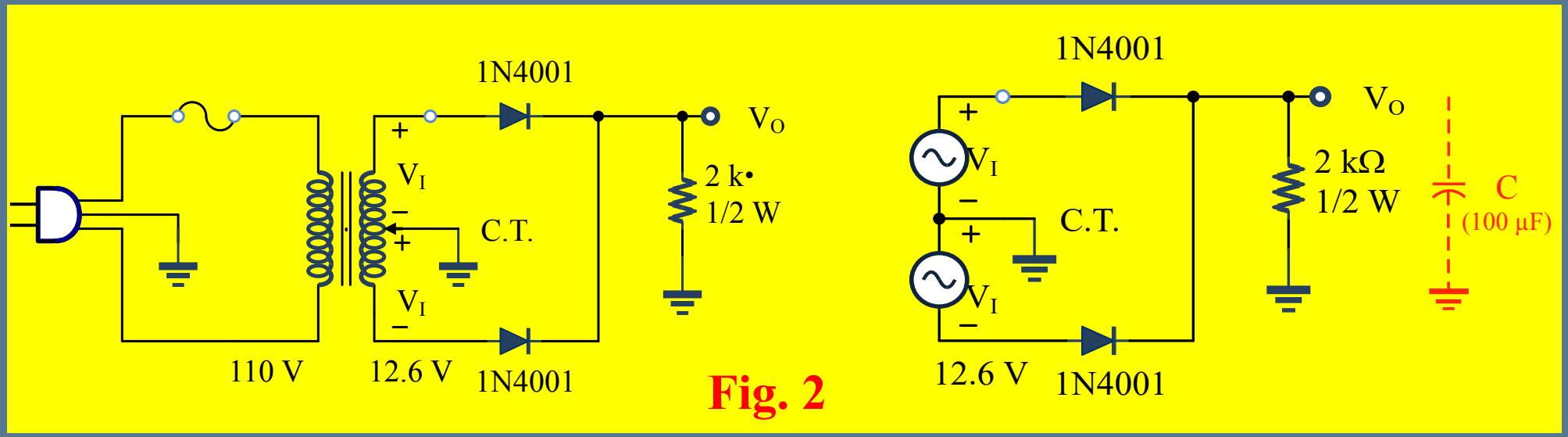


Fig. 2

Steps:

1. Connect the circuit as shown, use any of IN4001～IN4007for the diode.
2. The function generator is used instead of the transformer, set:
   a) $V_{p\text{-}p} = 20V$, $f = 1$ kHz sinusoidal waveform,
   b) $V_{p\text{-}p} = 5V$, $f = 1$ kHz sinusoidal waveform,
3. Record the input and output waveforms, discuss what you have found from your observation.
4. Measure **V_{DC}** of V_I and V_O by using a digital multi-meter.
5. Repeat step 1～4 for Fig. 2, if **C = 100 µF** is in parallel with the load.

Experiment 11.c Full-wave Rectifier with Diode-Bridge

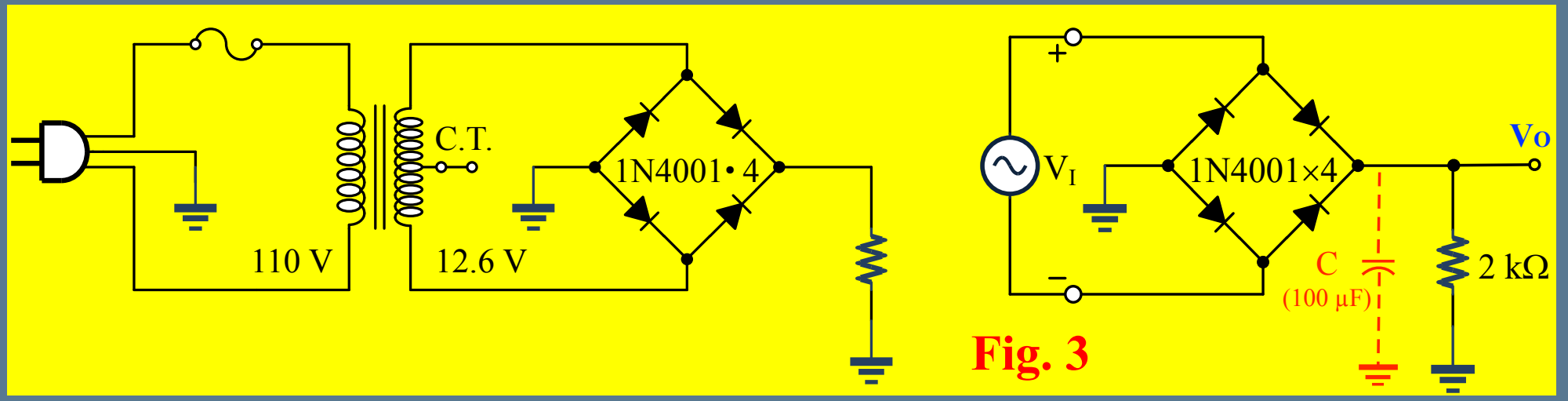


Fig. 3

Steps:

1. Connect the circuit as shown in Fig. 1, use any of IN4001～IN4007 for the diode.
2. The function generator is used instead of the transformer, set:
   a) $V_{p\text{-}p} = 20V$, $f = 1$ kHz sinusoidal waveform,
   b) $V_{p\text{-}p} = 5V$, $f = 1$ kHz sinusoidal waveform,
3. Record the input and output waveforms, discuss what you have found from your observation.
4. Measure **V_{DC}** of V_{DC} by using a digital multi-meter.
5. Repeat step 1～4 for Fig. 3, if **C = 100 μF** is in parallel with the load.