

# SE3910 – REAL TIME SYSTEMS

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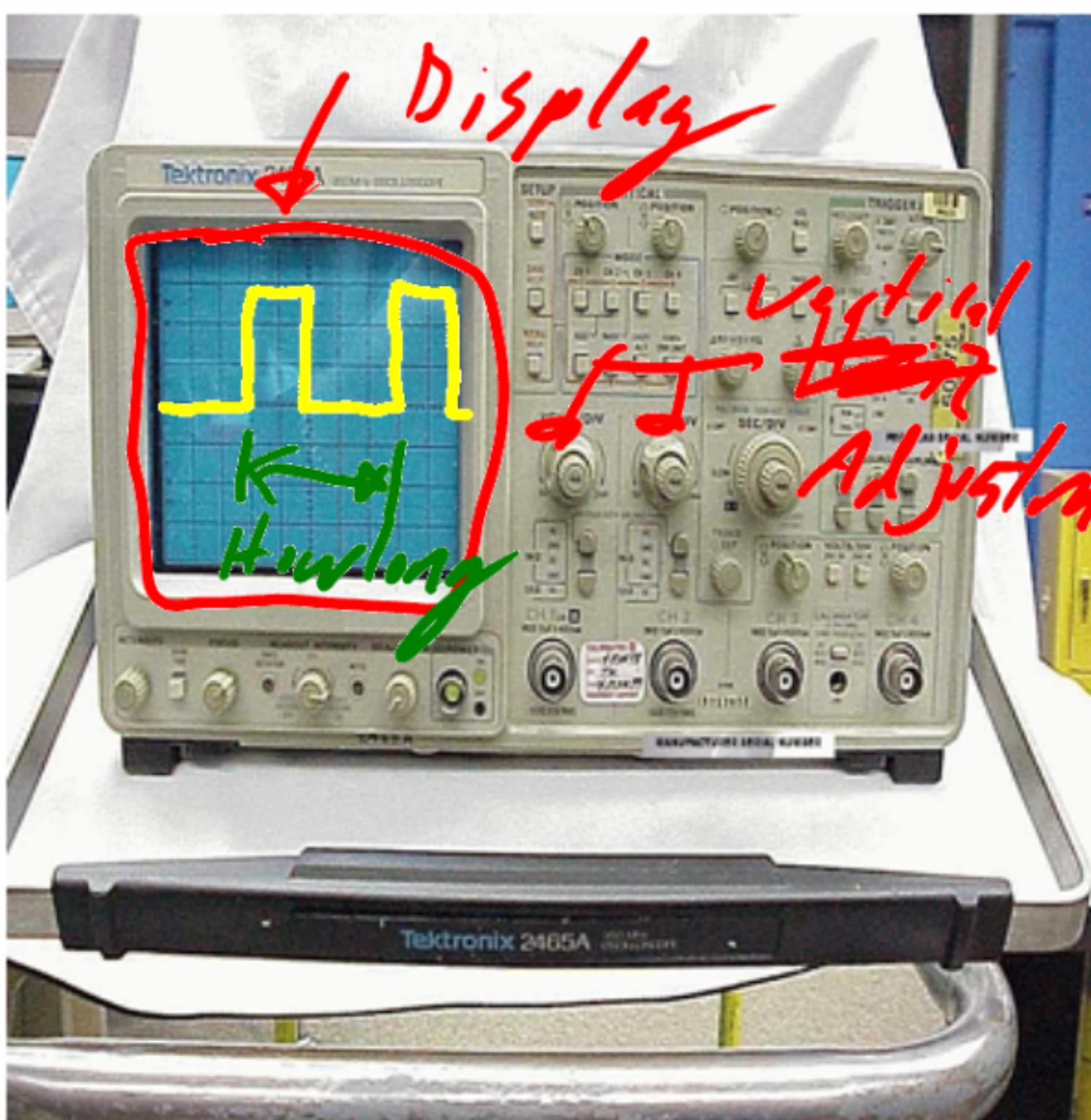
Measuring things with an Oscilloscope

# OBJECTIVES

- Explain the meaning of horizontal scaling on an oscilloscope. ←
- Understand the meaning of vertical scaling on an oscilloscope. —
- Understand the relationship between frequency and period.
- Recognize a square wave, a sine wave, and a saw tooth wave
- Using the oscilloscope, measure the peak voltage of a signal
- Explain the concept of a pulse width modulated waveform
- Measure the duty cycle of a pulse width modulated signal
- Explain the concept of rise time and fall time.
- Use an oscilloscope to measure the frequency and offset of two signals.
- Using the oscilloscope, measure the time difference between two signals

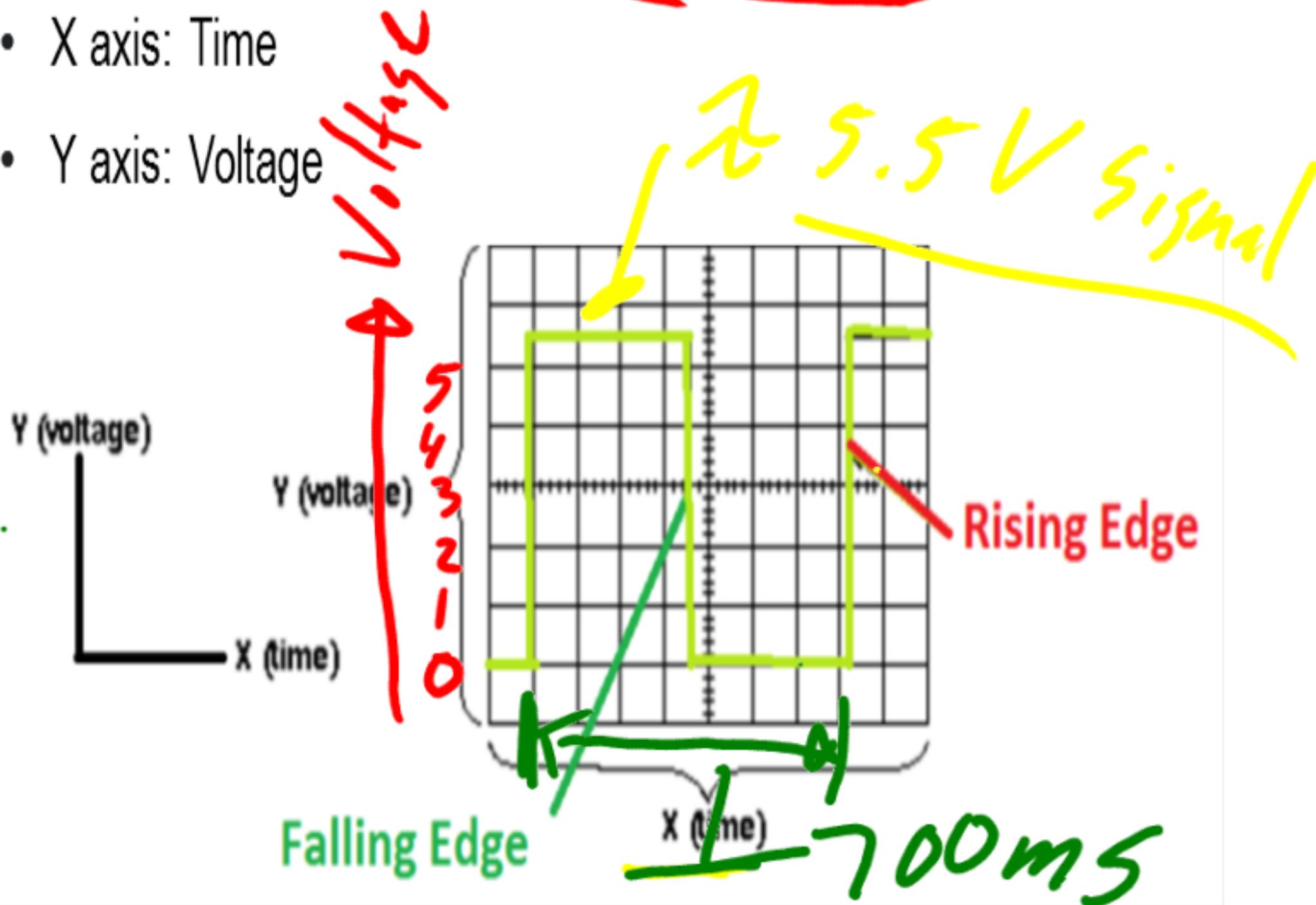


# WHAT IS AN OSCILLOSCOPE?



# WHAT IS AN OSCILLOSCOPE?

- A graph-displaying device of electrical signal
  - X axis: Time
  - Y axis: Voltage



# FREQUENCY VERSUS PERIOD

- Frequency
  - The number of times a signal completes a loop of rising and falling in a given unit of time, typically 1 second
    - Measured in Hertz (hz)
- Period
  - The length of time it takes for a signal to complete on complete transition start to finish, returning to where the signal started
    - Measured in units of time (s, ms, etc.)

- Lets see what some different frequencies look like and sound like...

DEMO

# WAVE SHAPES

- Sine wave



- Square wave



- Sawtooth Wave

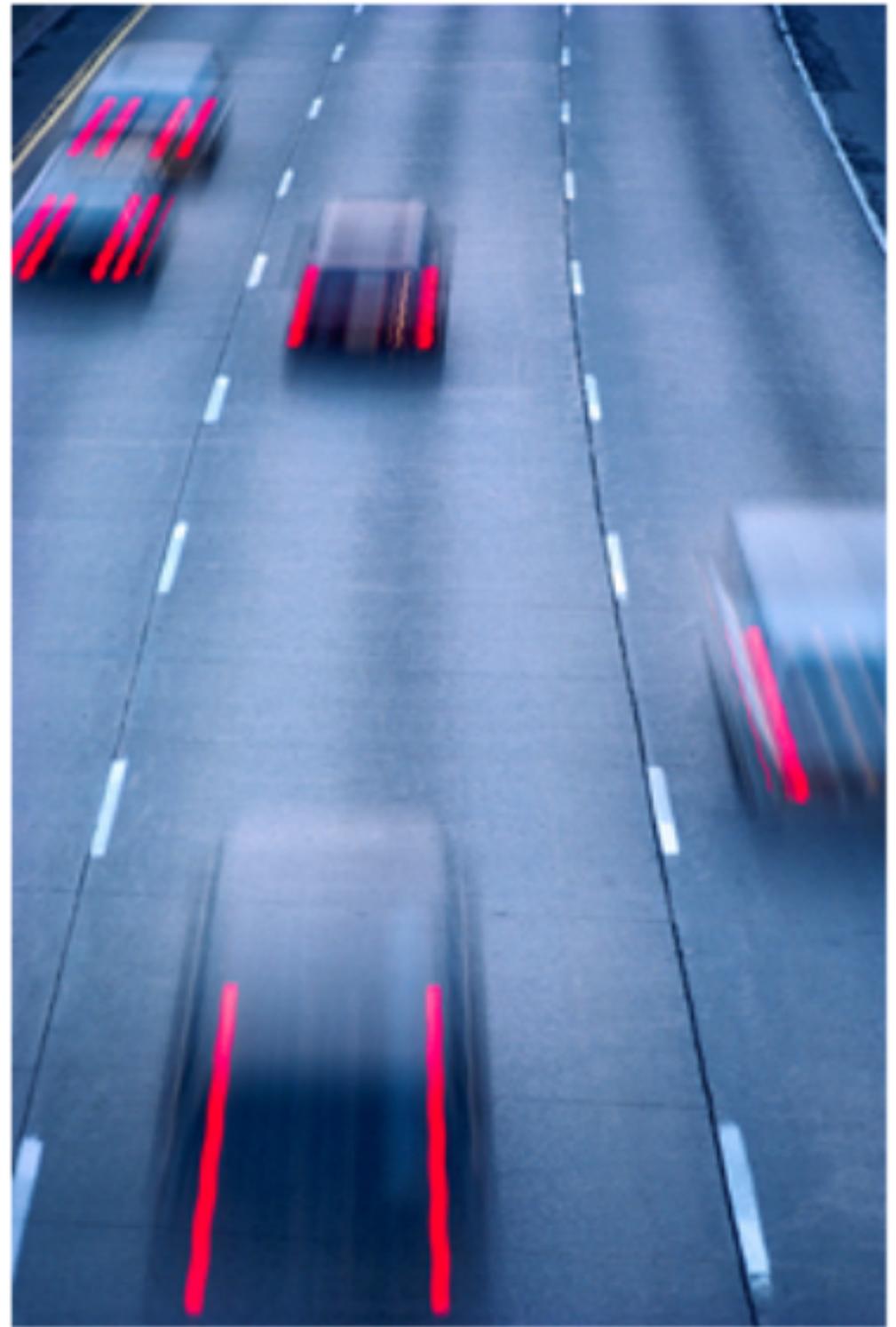


- How does one control the speed of a motor?

Pulse Width Modulated  
Signal

- How ~~does one~~ change the brightness of a light bulb?

# PWM PERSONIFIED



PWM

# PWM MEASUREMENT

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# CALCULATING THE EFFECTIVE VOLTAGE WITH PWM

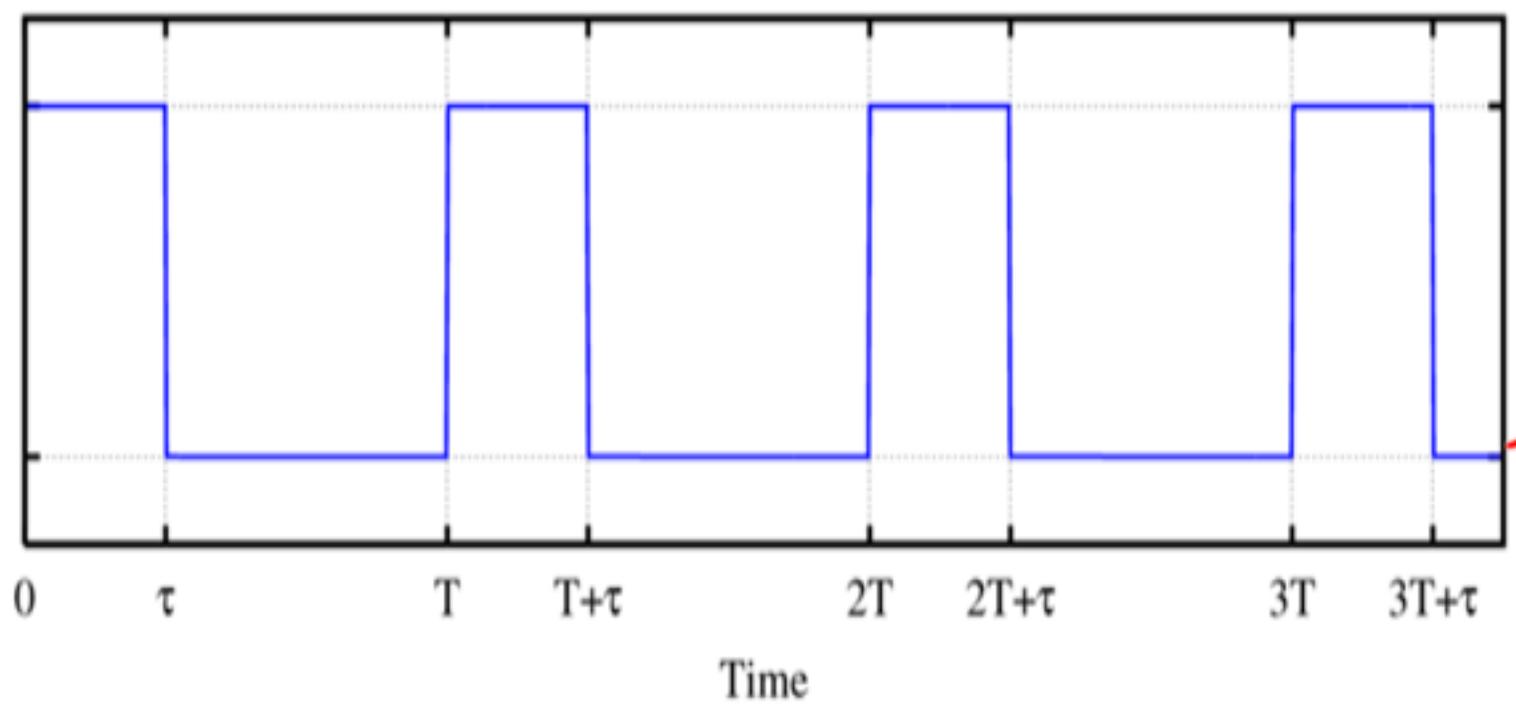
- Determine the duty cycle (D) *what percent of time is the signal high?*
- Multiply the duty cycle by the peak voltage ( $V_{eff}$ )

$$D = \frac{\tau}{T}$$

*on period* (pointing to  $\tau$ )  
*total period* (pointing to  $T$ )

$$V_{eff} = D \cdot V_P = V_P \cdot \frac{\tau}{T}$$

# CALCULATING THE EFFECTIVE VOLTAGE WITH PWM



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