Fundamentals of Electrical and Electronics Engineering
EECE105L

Department of ECE
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BENNETT
UNIVERSITY
A TIMES GROUP INITIATIVE

Evaluation Components

- Mid Term: **15 Marks** (LMS Quiz)
- End Term: **35 Marks** (LMS Quiz)
- Lab: **30 Marks** (Continuous Evaluation 10, Experiment Performance 10, Quiz on Experiment 10)
- Continuous Evaluation- **20 Marks** (Includes LMS Quiz and Assignment)

While Solving Numerical Problem You may **use Scientific Calculators**

Text Book

1. ‘Introductory Circuit Analysis’ by Robert L Boylestad, Pearson (Available in Library)

2. ‘Electronic Devices and Circuit Theory’ by Robert L Boylestad and Louis Nasshelsky, Pearson (Available in Library)

Module 1

Fundamental Electrical Parameters

- **Charge** is an electrical property of the atomic particles that governs how the particles are affected by an electric or magnetic field, measured in coulombs (C).

- The *law of conservation of charge* states that charge can neither be created nor destroyed, only transferred. Thus, the algebraic sum of the electric charges in a system does not change.

- The electronic charge $e = -1.602 \times 10^{-19}$ C.

- **Current**: Electric current is the time rate of change of charge, measured in amperes (A)

1 ampere = 1 coulomb/second

$$\boxed{i = \frac{dq}{dt}}$$

- If the current does not change with time, but remains constant, we call it a direct current (dc). An alternating current (ac) is a current that varies sinusoidally with time.

Fundamental Electrical Parameters…Continued

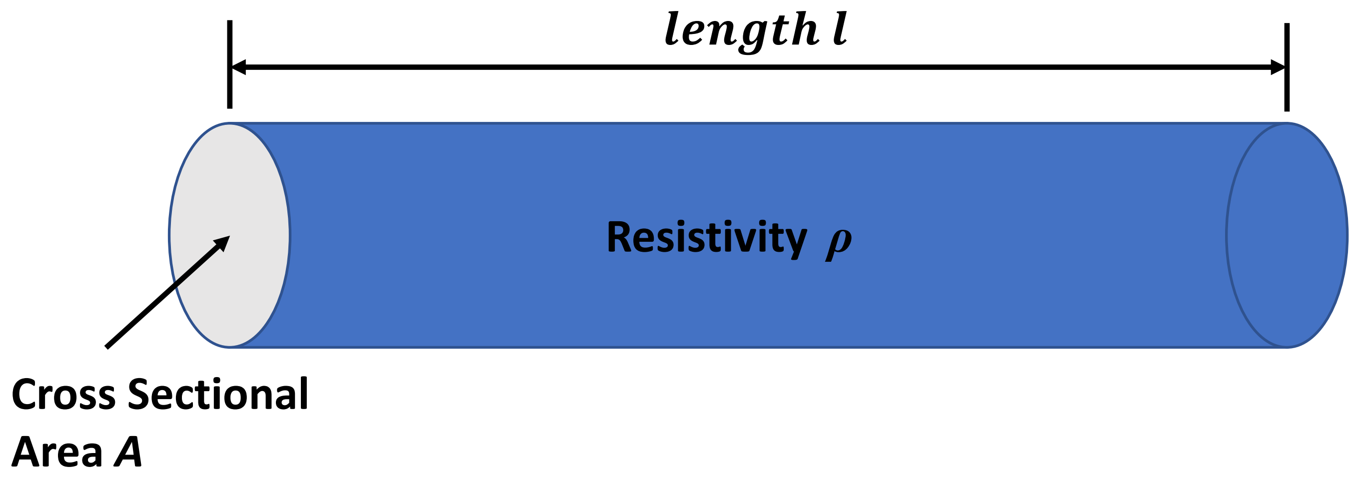
- **Electric field** is defined as the electric force per unit charge. The direction of the field is considered to be the direction of the force it exerts on a positive test charge. The electric field is radially outward from a positive charge and radially inward to a negative point charge.

- **Voltage** (or potential difference) is the energy required to move a unit charge from one point to another point, measured in volts (V).

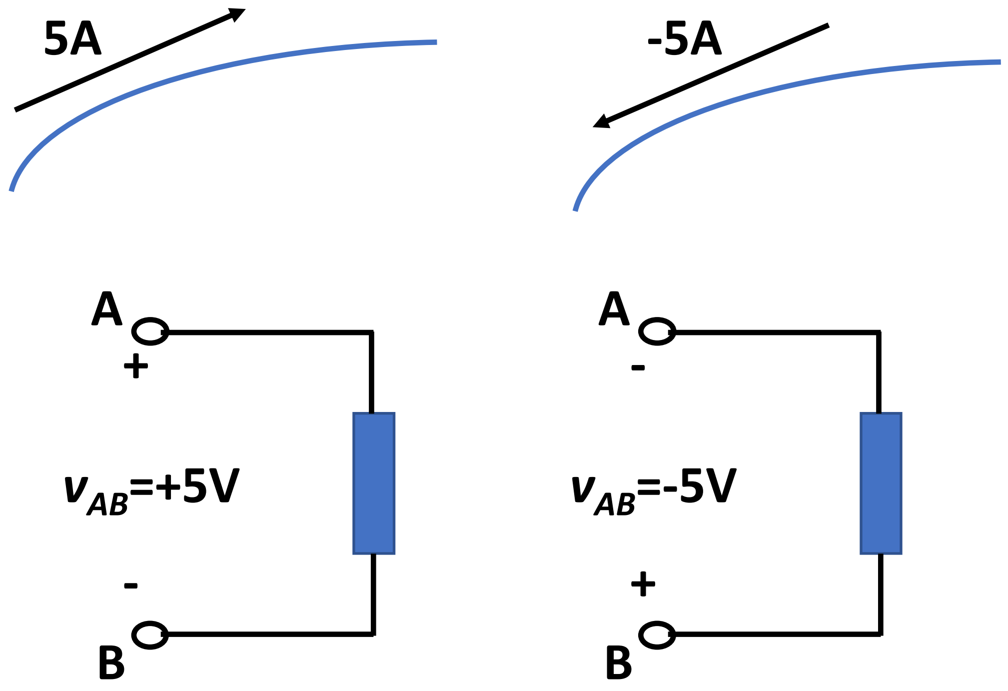
$$v = \frac{dw}{dq}$$

- **Resistance** *R* of an element denotes its ability to resist the flow of electric current; it is measured in ohms (Ω).

$$R = \rho \frac{l}{A}$$



Current and Voltage Polarity and Ground



- In all the electrical and electronics circuits there is a reference node called **ground** which is considered as 0V. All other node voltages are measured with respect to this reference ground voltage.

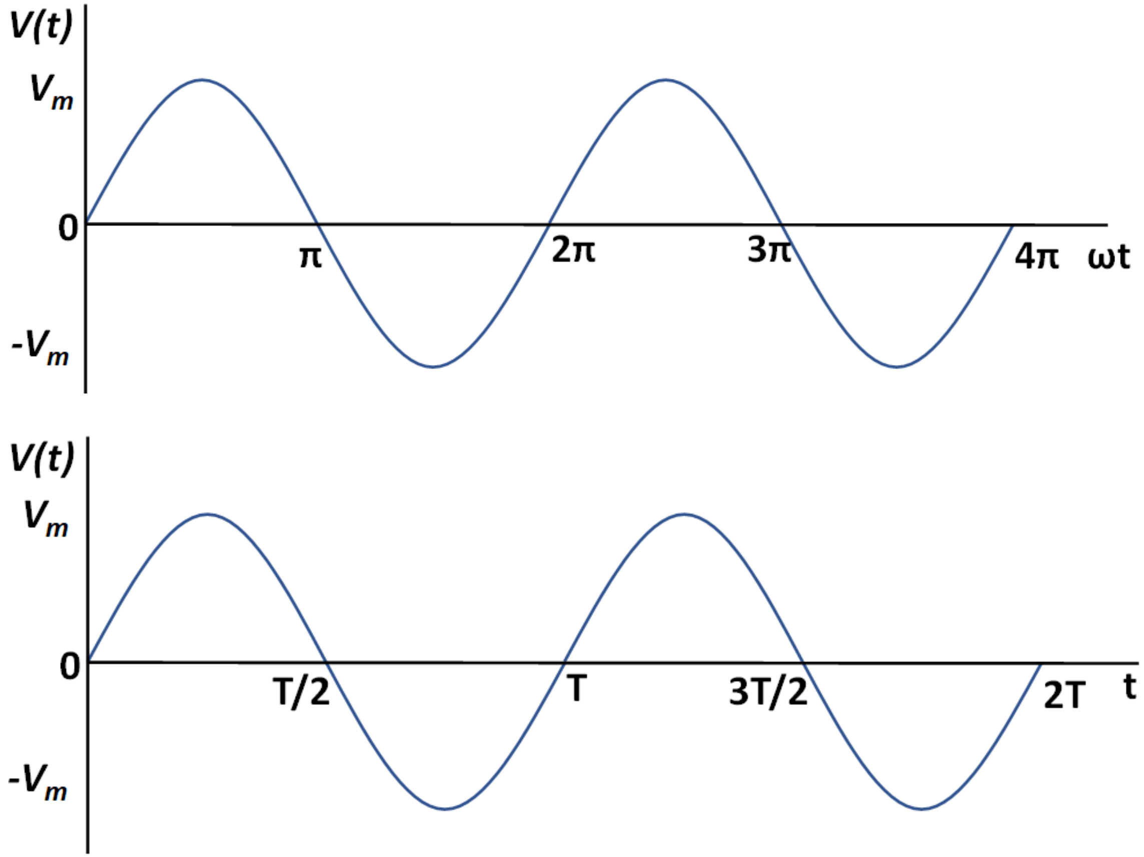
Periodic Signal

- A **periodic function** is one that satisfies $f(t) = f(t + nT)$, for all t and for all integers n.

- Consider the sinusoidal voltage

$$v(t) = V_m \sin\omega t$$

Where,
V_m = the amplitude of the sinusoid
ω = the angular frequency in radians/s
ωt = the argument of the sinusoid



The sinusoid repeats itself every *T* seconds; thus, *T* is called the *period* of the sinusoid

$$\omega T = 2\pi \quad \text{or} \quad T = \frac{2\pi}{\omega}$$

$$v(t + T) = v(t)$$

Periodic Signal…Continued

- The **period** *T* of the periodic function is the time of one complete cycle or the number of seconds per cycle.

- The reciprocal of this quantity is the number of cycles per second, known as the *cyclic frequency f* of the sinusoid.

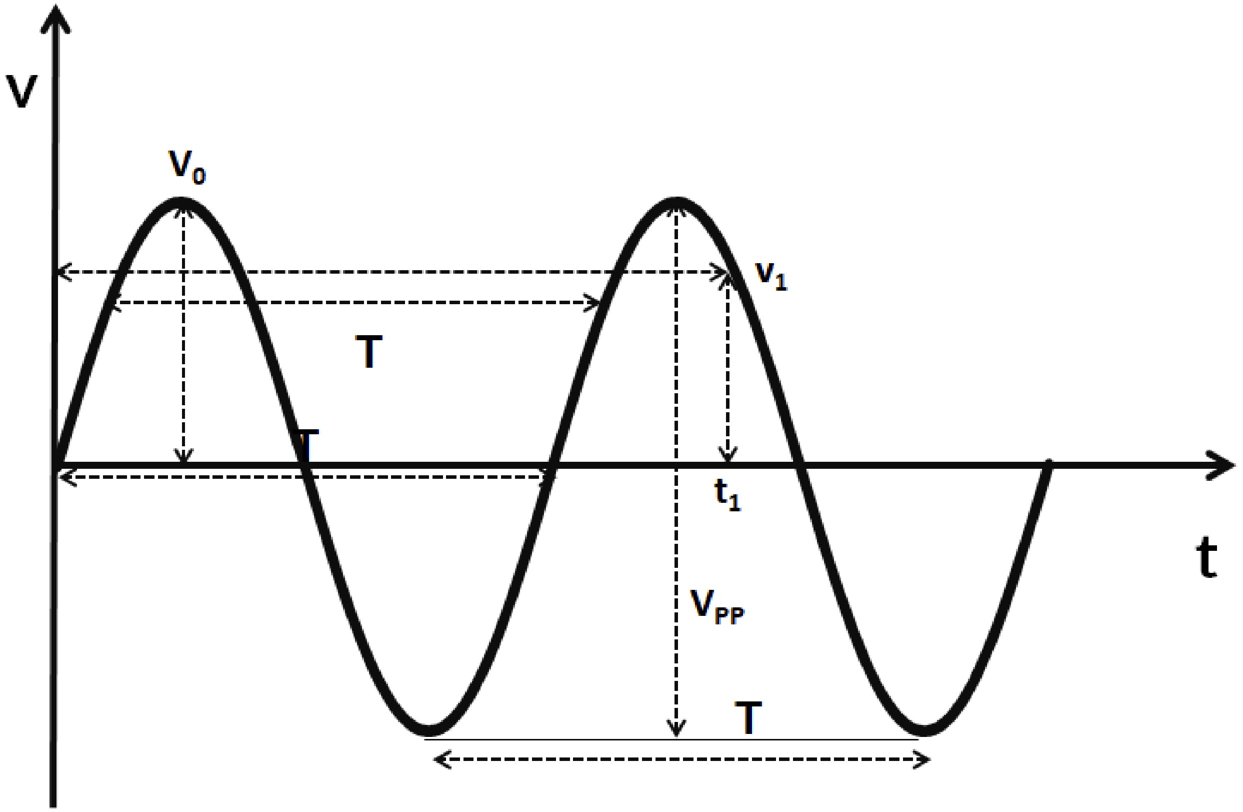
Few Components of Periodic Signal

Definitions:

Waveform: The path traced by a quantity (for example: voltage, current) plotted as a function of some variable (for example time, position, degrees, radians).

Instantaneous value: The magnitude of a waveform at any instant of time; denoted by lowercase letters (v_1 in the figure).

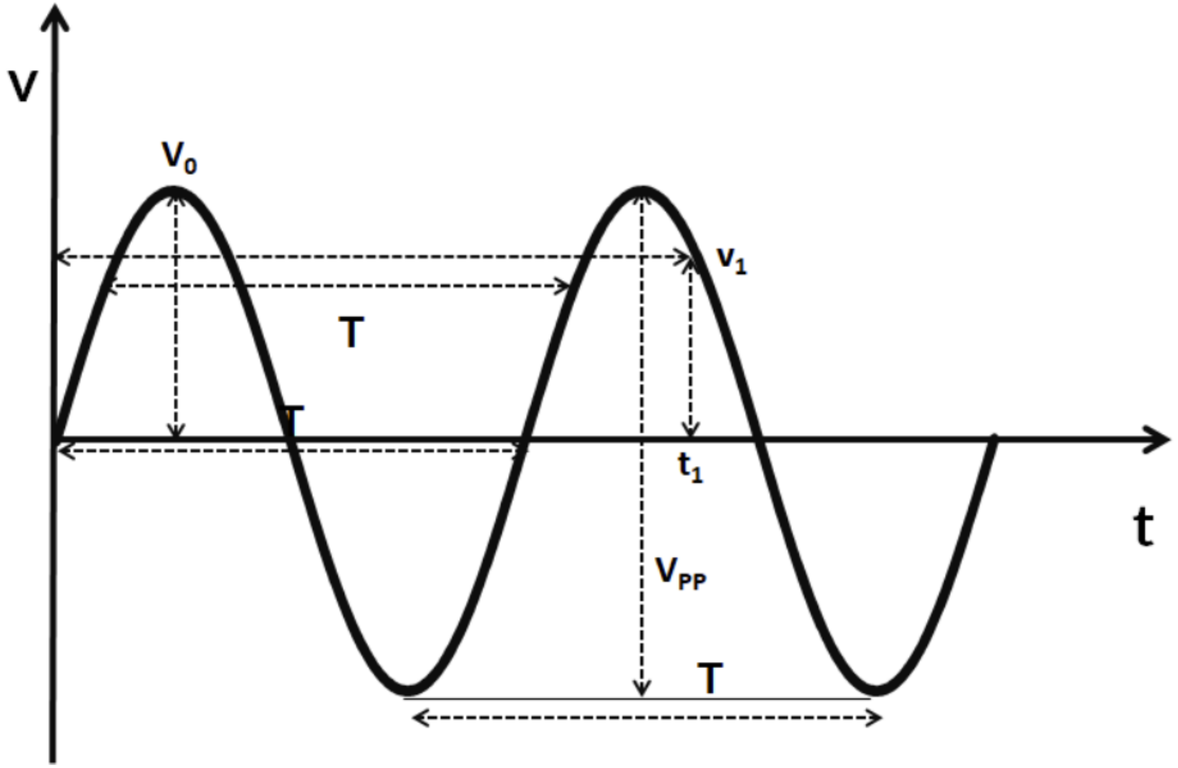
Peak amplitude: The maximum value of a waveform as measured from its average, or mean value, denoted by uppercase letters. In the waveform shown in figure, the average value is zero volts, and peak amplitude V_0 is as defined in figure.



A sinusoidal waveform

Few Components of Periodic Signal…Continued

Peak value: The maximum instantaneous value of a function as measured from the zero-volt level. For the waveform, the peak amplitude and peak value are the same, since the average value of the function is zero volts.



Peak-to-peak value: Denoted by V_{PP} (as shown in figure), peak to peak voltage is the full voltage between positive and negative peaks of the waveform, that is, the sum of the magnitude of the positive and negative peaks.

Periodic waveform: A waveform that continually repeats itself after the same time interval. The waveform in figure is a periodic waveform.

Period (T): The time required for one complete cycle.

Cycle: The portion of a waveform contained in one period.

Few Components of Periodic Signal…Continued

Average Value: Average Value of an ac wave is defined as the average of all the instantaneous values of a wave over an interval. Generally, average over one complete cycle is considered in electronics. The average value is estimated by finding area under curve. Mathematically, if *f(t)* describes the wave equation, then the area under the curve for a base between two instants t_1 and t_2 is given by:

$$Area = \int_{t_1}^{t_2} f(t)dt$$

The average value is given by:

$$V_{avg} = \frac{\int_{t_1}^{t_2} f(t)dt}{t_2 - t_1}$$

RMS Value: Root Mean Square or RMS value is defined as the square root of means of squares of instantaneous values. The RMS value is estimated by finding the area under the square of the curve. Mathematically, if *f(t)* describes the wave equation, then the RMS of the wave for a base between two instants t_1 and t_2 is given by:

$$V_{rms} = \sqrt{\frac{\left(\int_{t_1}^{t_2} f(t)dt\right)^2}{t_2 - t_1}}$$

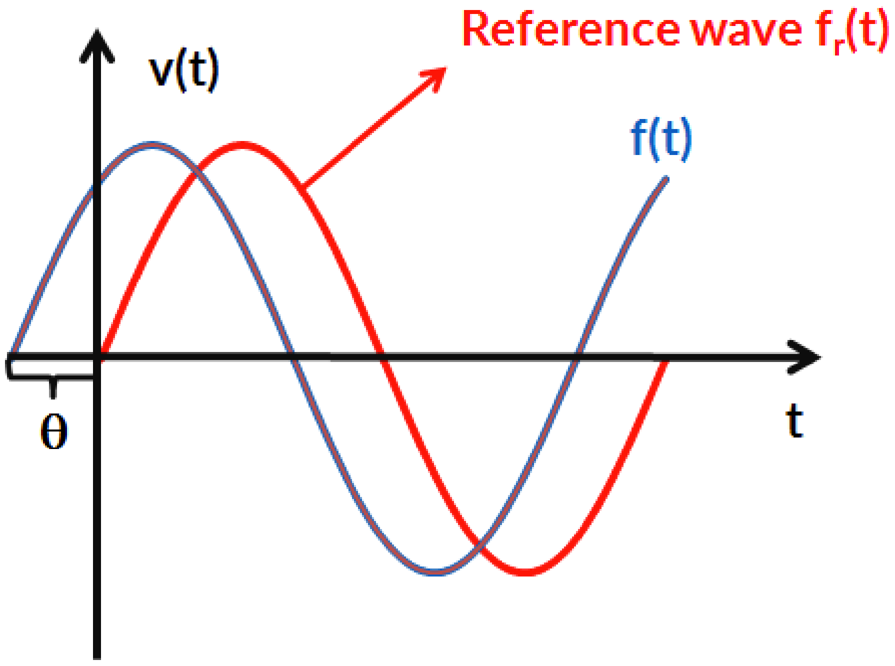
Phase Difference

Consider the figure. When compared to $f_r(t)$, the wave f(t) has a greater instantaneous value at position t=0. If $f_r(t)$ is given by Eq (1), then f(t) is given by Eq (2).

$$f_r(t) = A_m \sin(wt) \qquad (1)$$

$$f(t) = A_m \sin(wt + \theta) \qquad (2)$$

Thus, f(t) leads $f_r(t)$ by an angle θ or in general, it is said that f(t) and $f_r(t)$ are out of phase by an angle θ.



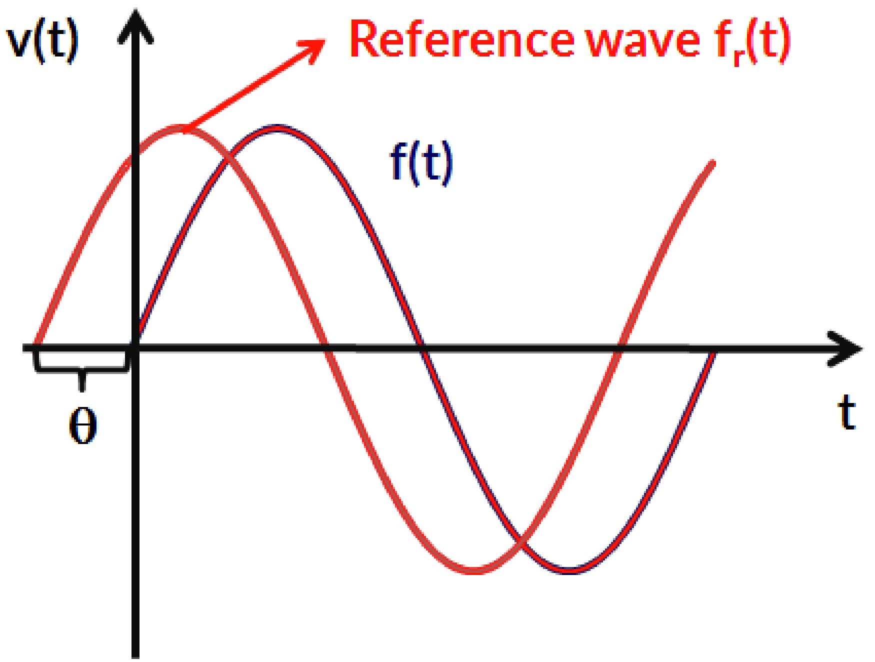
f(t) leads $f_r(t)$ by an angle θ

Phase Difference…Continued

Now, consider the given fig. When compared to f(t), the wave $f_r(t)$ has a greater instantaneous value at position t=0. If $f_r(t)$ is given by Eq (1), then f(t) is given by Eq (3).

$$f(t) = A_m \sin(wt - \theta) \qquad (3)$$

Thus in general, it is said that $f_r(t)$ and f(t) are out of phase by an angle θ, or more precisely f(t) lags $f_r(t)$ by an angle θ.



$f_r(t)$ leads f(t) by an angle θ