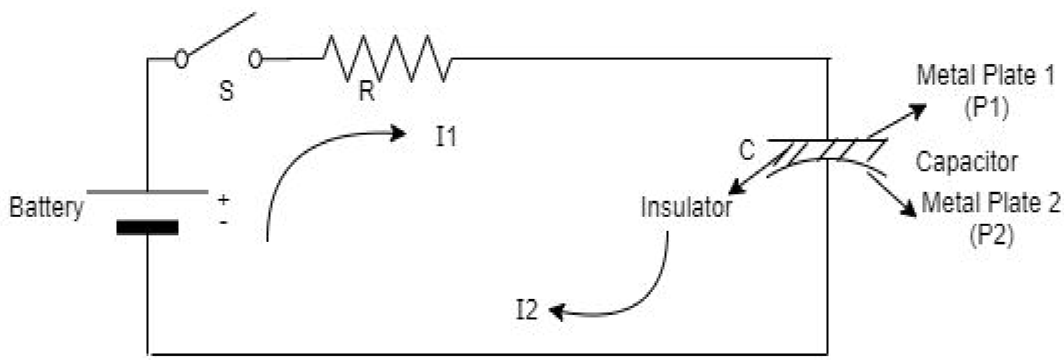
Satellite & Mobile Communication Network

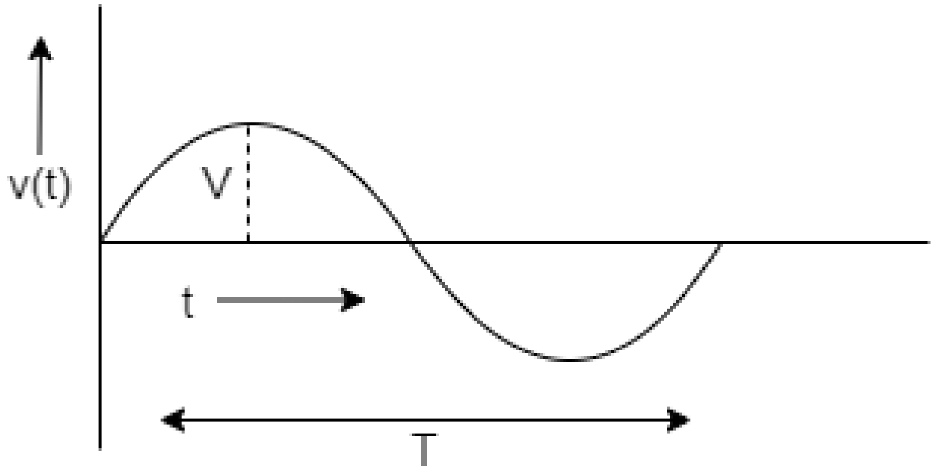
12.08.2020

1. Electromagnetic wave:
    a. $\vec{E}$ field (Electrical field)
    b. $\vec{H}$ field (Magnetic field)
    c. Both are vectors.
    d. $\vec{E}$ field and $\vec{H}$ field produced naturally at right angles.
    e. Direction of propagation of Electromagnetic field is at right angle to the plane of $\vec{E}$ and $\vec{H}$ field.
2. Constant voltage source



   a. Initial current (I_1) ON switch (S)
      ON = $\frac{V}{R}$ = **Conduction current**
   b. This shall put +ve charge (Q) on P_1 plate.
   c. Create an electric field $\vec{E}$ through an insulator.
   d. This electric field $\vec{E}$ shall displace positive charge Q from P_2.
   e. So there will be current from plate P_2.
   f. According to **Kirchhoff's law** $I_1 = I_2$.
   g. No current really flows through the insulator of the capacitor.
   h. But to justify Kirchhoff's law there must be some virtual current through the insulator. This virtual current is known as the **Displacement current**.

3. Varying voltage
   $v(t) = V sin(2\pi f t + \phi)$
   This is graphically presented as :
   Case 1 : $\theta = 0$

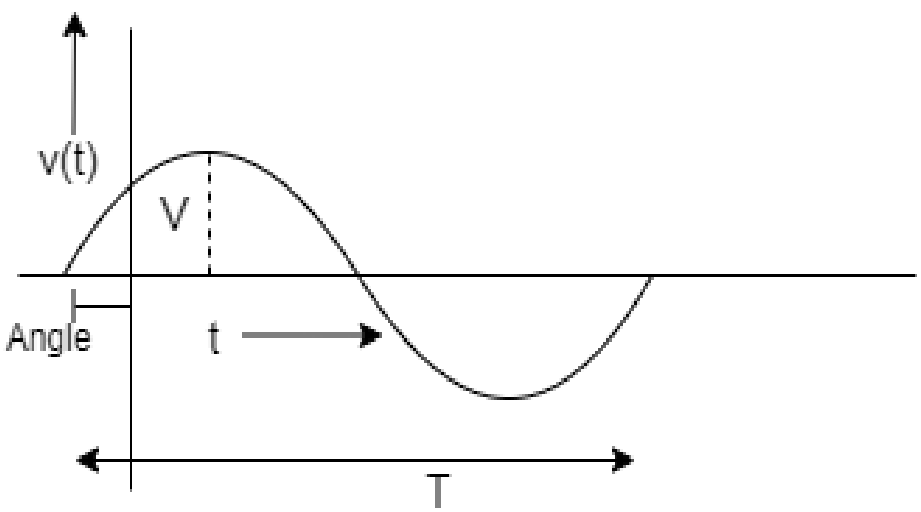


$V \ = \ Amplitude$

$T \ = \ Time\ period$

$f \ = \ \frac{1}{T} \ = Cyclic\ frequency$

Case 2 : $\phi \ = \ \theta$



Angle = Theta = θ

2π angle for one time period T :

a. $2\pi \rightarrow T\ (Time)$

   $1 \rightarrow \frac{T}{2\pi}$

   $\theta = \frac{T\theta}{2\pi}$ radian

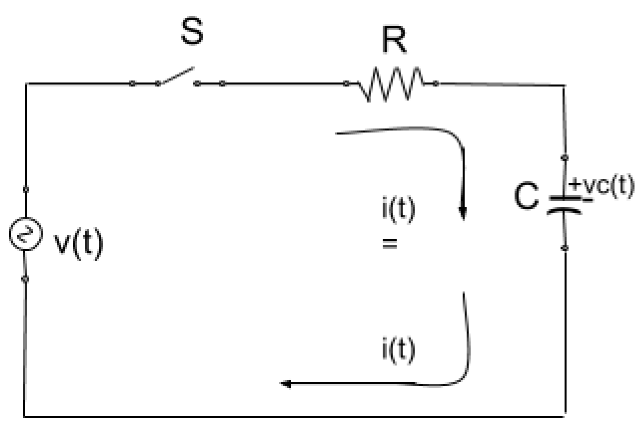
b. We say this sine wave is leading by an angle θ w.r.t earlier wave.

c. Three parameters of sine wave:

   $v(t) \ = \ V\,sin(2\pi f t \ + \ \phi)$

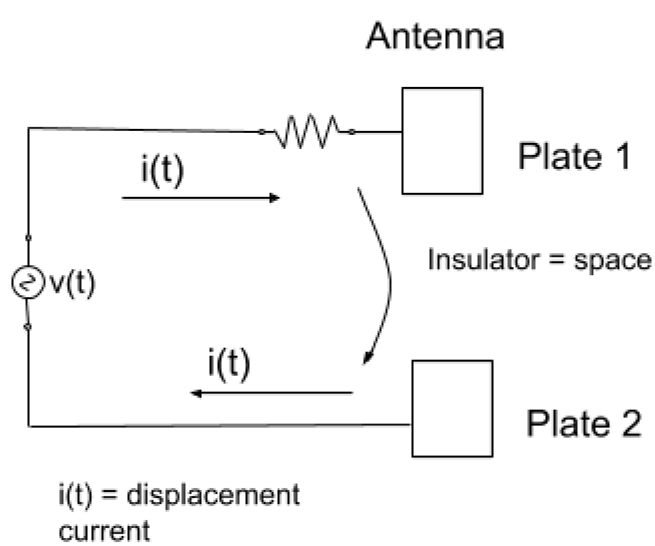
$v(t)$ = *Instantaneous value of the sine wave*
V = *Amplitude*
$f = \frac{1}{T}$ = *Cyclic frequency*
ϕ = *Phase angle*

4. $\frac{v(t) - vc(t)}{R} = i(t)$ = *displacement current*



a. Say switch S is ON at **t = 0** and capacitor voltage $vc(0^-) = 0$
$vc(0) = 0$, as a capacitor cannot charge instantaneously.
b. At **t**, current $vc(t)$ = *some positive value*
c. $i(t) = \frac{v(t) - vc(t)}{R}$
d. Displacement current at t = i(t)

5. Time varying conduction current in circuit, i(t)
Time varying displacement current in space(air) = i(t)

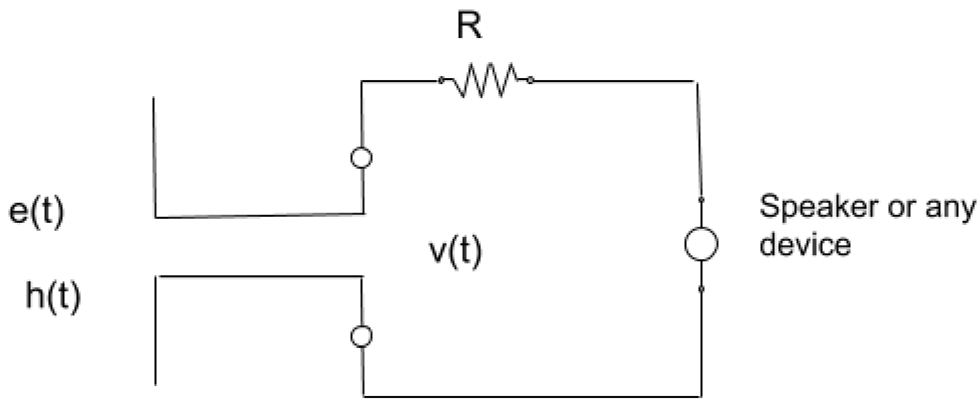


6.

a. Initially, there should be time varying $\vec{e}(t)$ in insulated space(sinusoid, if v(t) is sinusoid)
b. This results in time varying displacement current in space = i(t)
c. i(t) → According to Biot-Savat law, this will give rise to magnetic field (time varying) $\vec{h}(t)$.
d. If v(t) is sinusoid, then $\vec{e}(t)$ and $\vec{h}(t)$ will also be sinusoid.

e. So in space there will be $\vec{e}(t)$ and $\vec{h}(t) \rightarrow$ electromagnetic field $\rightarrow$ it will travel in all directions.

7. Receiving antenna



Case 1: When $\vec{e}(t)$ is horizontal (perpendicular to the rod)

$v(t) = 0$

Case 2: When $\vec{e}(t)$ is vertical

$v(t) \neq 0$