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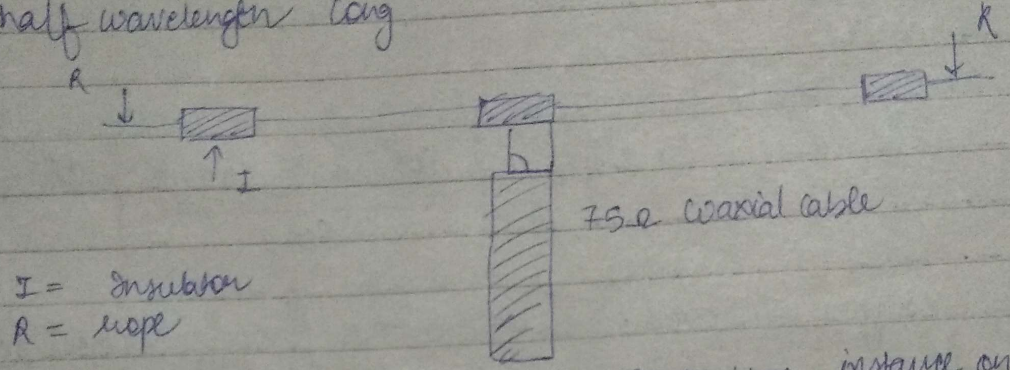
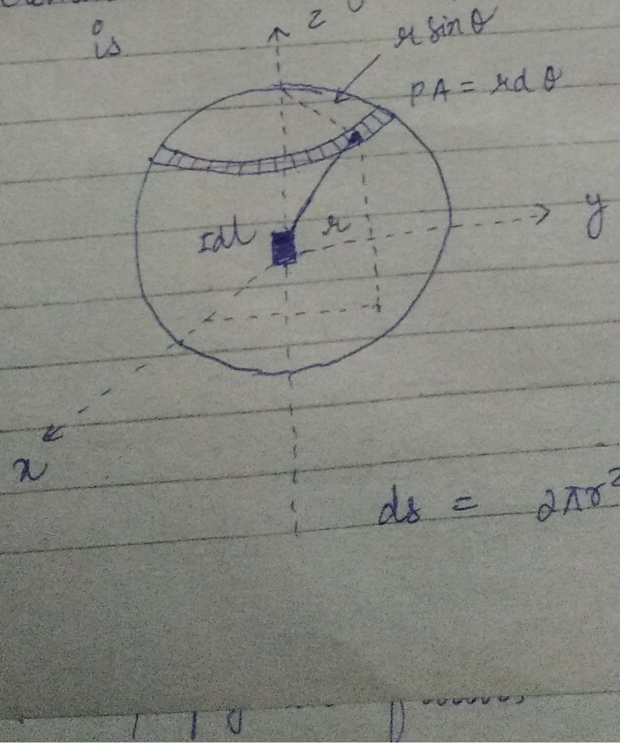
Ans (1) (a) Half wave dipole is formed from conducting element which is wire or metal tube which is an electrical half wavelength long




The current profile is same at any given time instance on both radiators, each of quarter wavelength. If we send through centre wire and the bind of coaxial cable is always at ground. For dipole antenna, the inductive and capacitive reactance level cancel each other.

Ans (1) (b) We can calculate the total power radiated by a $\lambda/2$ antenna and its radiation resistance as same as has been adopted in case of current element power calculations.

The elemental area of spherical shell from below figure is




$$ds = 2\pi r^2 \sin\theta \, d\theta$$

Total power radiated from $\lambda/2$ antenna

is calculated from
$\psi$ radiation half wave dipole

$$P = \oint_S P_{av}\, ds$$

$$= \int_0^{\pi} \frac{30 I_{rms}^2}{\pi r^2} \left\{ \frac{\cos^2(\pi/2 \cos\theta)}{\sin^2\theta} \right\} 2\pi r^2 \sin\theta\, d\theta$$

$$= 60 I_{rms}^2 \int_0^{\pi} \left\{ \frac{\cos^2(\pi/2 \cos\theta)}{\sin\theta} \right\} d\theta$$

solving using Simpson's rules $\longrightarrow \int_0 \frac{\cos^2(\pi/2 \cos\theta)\, d\theta}{\sin\theta}$

$$\therefore\ P = 60 I_{rms}^2 \times 1.219$$

$$P = 73.140 I_{rms}^2$$

$$P_r = I_{rms}^2 R_r$$

Total power radiated by half wave dipole

$$\boxed{R_r = 73.14 \approx 73\ \Omega}$$

Ans (1) (C) Reciprocity states that the recieve and transmit properties of an antenna are identical. Hence, antenna do not have distinct transmit and recieve radiation pattern - if you know the radiation pattern in transmit mode then you also know pattern in recieve mode.

The properties of transmitting and recieving antenna that exhibit the reciprocity are -

- Equality of directional pattern
- Equality of Directives
- Equality of effective length
- Equality of Antenna impedances

If any linear & bilateral network consisting the linear and bilateral impedance the ratio of voltage V applied between any two terminals to the current I measured in any branch is same as ratio V to I obtained by interchanging the positions of voltages source and the ammeter used for current measurement.

Ans (4) (a) Beam Efficiency

Beam efficiency states ~~that~~ the ratio of the beam area to the main beam to the total beam area radiated

The energy when radiated from an antenna, is projected according to antenna's directivity. The direction in which an antenna radiates more power has maximum effeciency, while some of the energy is lost is side lobes. The maximum energy radiates by the beam, with minimum losses can be termed as beam effeciency

$$\eta_B = \frac{\Omega_{MB}}{\Omega_A}$$ beam area of main beam / total solid beam angle

(b) Antenna Efficiency.

The efficiency of an antenna is a ratio of power delievered to the antenna relative to power radiated from the antenna. A high effeciency antenna has most of the power present at the antenna's input radiated away

$$\epsilon_R = \frac{P_{radiated}}{P_{input}}$$

A low antenna has most of the power absorbed as losses within the antenna, or reflected away due to impedance mismatch

Radiating near field

(C) The field surrounding an antenna are divided in 3 categories —

(i) Far field

At the far field region, where $r >> \lambda/2\pi$, $1/r^2$ and $1/r^3$ terms are neglected to gives the radiated field components with $1/r$ variation only

$$H_\phi = j \frac{K I_o dl}{4\pi r} e^{-jkr} \sin\theta$$

$$E_\theta = j\eta \frac{k I_o dl}{4\pi r} e^{-jkr} \sin\theta$$

(ii) Near field

In the region where $r < \lambda/2\pi$, the terms with $r^2$ and $r^3$ dominate are called near field

(iii) Reactive field

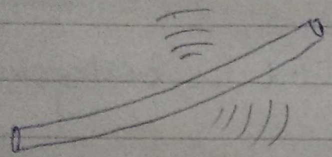
In the region where $r << \lambda/2\pi$, the terms with $r^3$ are dominating and are called reactive field. The radiated energy is stored & doesn't help in propagation of waves.

Chapter-13

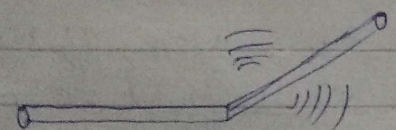
Ans (9) (d) Antenna Array

Antenna array is radiating system, which consist of individual radiator and elements. Each of this radiator while functioning has it's own induction field. The elements are placed so closely that each one lies in the neighbouring one's induction field. Therefore the radiation pattern produced by them, would be vector sum of individual ones.

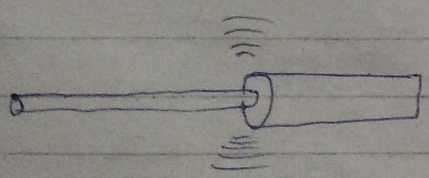
Ans (2) (a) Radiation mechanism of in antennas



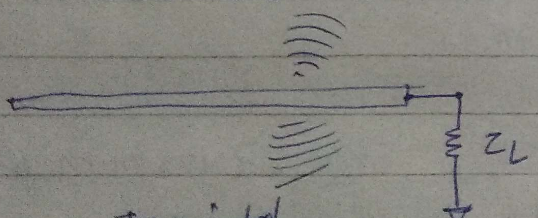
Curved



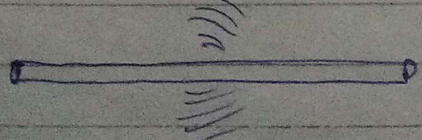
Bent



Discontinous




Terminated



Transcated

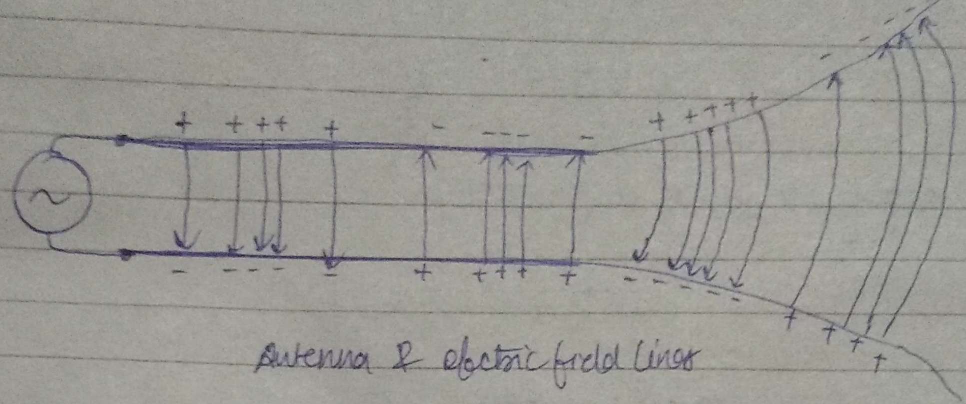
1. charge is not moving
   No current, no radiation

2. Charge is moving uniform velocit
   a. Wire is straight and infinite, no radiation
   b. Wire is curved, bent, discontinuo terminated or truncated it makes radiation

3. Charge is oscillating
   It radiates even if wire is straight

Single wire

For two wires

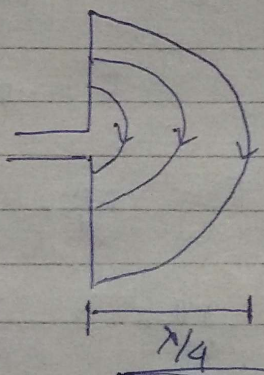


Antenna & electric field lines

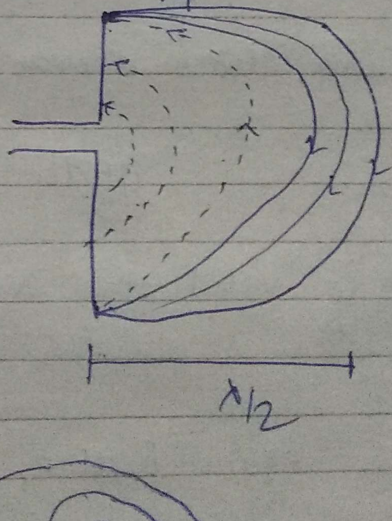
On applying voltage, it creates an electric field between conductors. Electric lines of force ∝ Electric field intensity. Electric charges are required to excite the field but are not needed to sustain them and may exist in absence

Radiation mechanism

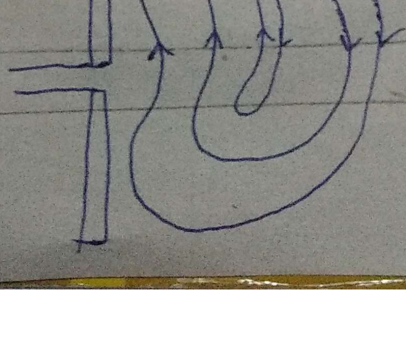
ⓐ ⇒ $t = T/4$ ($T$ = period)



ⓑ ⇒ $t = T/2$ ($T$ = period)



ⓒ $t = T/2$ ($T$ = period)



Ans (2) (b) We know $B = \nabla \times A$ ← magnetic vector potential

$$\nabla \times E = \frac{-\partial B}{\partial t} = -\frac{\partial}{\partial t}(\nabla \times A)$$

by changing order of differentiation,

$$\nabla \times E = -\nabla \times \frac{\partial A}{\partial t}$$

$$\nabla \times \left(E + \frac{\partial A}{\partial t}\right) = 0$$

$$E + \frac{\partial A}{\partial t} = -\nabla V$$

For steady DC current, A is considered constant so,

$$E = -\nabla V$$

$$E = -\frac{\partial A}{\partial t}$$

$$\oint E\,dl = \frac{\partial \phi}{\partial t} = -\frac{\partial}{\partial t}\int_S B\,ds = \frac{-\partial}{\partial t}\int_S B \cdot ds$$

Using stokes theorem

$$\oint_l E\,dl = -\oint \frac{\partial A}{\partial t}\,dl$$

So, $E = -\frac{\partial A}{\partial t}$ is valid for any arbitrary path at each point as long as $E_r$ is an induced field intensity.

$$\text{So,} \quad E \cdot dl = \frac{-\partial A}{\partial t} \cdot dl$$

$$E_\phi = \frac{-\partial A}{\partial t}$$

where $E_a$ is a component caused by charge in vector magnetic potential,

$$E = E_A + E_F$$

$$= -\nabla V - \frac{\partial A}{\partial t}$$

due to charge → due to time varying current

$$V = \frac{1}{4\pi\epsilon}\iiint \frac{\rho\, dv}{r} \text{ volts}$$

$$A = \int_v \frac{\mu}{4\pi}\left(\frac{J}{r}\right) dv \text{ wb/m}$$

$$\boxed{E = E_A + E_F = -j\omega A - j\frac{1}{\omega\mu\epsilon}\nabla(\nabla \cdot A) - \frac{1}{\epsilon}\nabla \times F}$$

$$\boxed{H = H_A + H_F = \frac{1}{\mu}\nabla \times A - \frac{1}{j\omega\mu}\nabla \times E_F}$$