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Ans 1 Section 2

Refraction critical frequency :→

- In radio propagation by way of the ionosphere, the limiting frequency at or below which a wave component is reflected by and above which it penetrates through, an ionospheric layer.
- ~~Cri~~ Critical frequency changes with time of day, atmospheric condition and angle of fire of the radio waves by antenna.
- In signal processing the critical frequency it's also another name for the Nyquist frequency.

Critical frequency is the highest magnitude of frequency above which the wave penetrate the ionosphere and below which the wave are reflected back from the ionosphare. It is denoted by fc. Its value is not fixed and It depends upon the electrons density of the ionosphere.

Equations:

Critical frequency as a function of max. usable freqency formula.→

Critical frequency can be computed by:

$$f_c = \frac{MUF}{\sec\theta}$$

where MUF is maximum usable frequency and θ is the angle of incidence.

Relationship with Plasma frequency:⇒

The dependence of critical frequency with respect with electron density can be related through plasma oscillation concept particularly the cold electrons mechanism

$$\omega_{pe} = \sqrt{\frac{n_e e^2}{m^* \epsilon_0}}, \ [\text{red/sec}]$$

$e = 1.602 \times 10^{-19}$ Coulombs
$m^* = 9.1093 \times 10^{-31}$ kg
$\epsilon_0 = 8.8541 \times 10^{-12}\ A^2 s^4 m^{-3} kg$
$\omega_{pe} = 2\pi f = 56.415 \sqrt{n_e}$
$f_c = 8.979 \sqrt{N_{max}} \simeq 9\sqrt{N_{max}}$

Relationship with index of Refraction!

The relation between the electron number density N and the index of refraction n in the ionosphere when collisions are neglected.

$$n^2 - 1 = \frac{-Ne^2}{\epsilon_0 m \omega^2}$$

using the default values for electron charge e, permittivity of free space and electron mass ϵ_0 and changing angular velocity ω with respect to frequency f the yields to

$$n^2 - 1 = \frac{3182.607\,N}{(2\pi f)^2}$$

$$\Rightarrow \boxed{n = \sqrt{1 - \frac{80.616N}{f^2}} \approx \sqrt{1 - \frac{81N}{f^2}}}$$

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