(8) 44
April 2024

SCHEME OF VALUATION

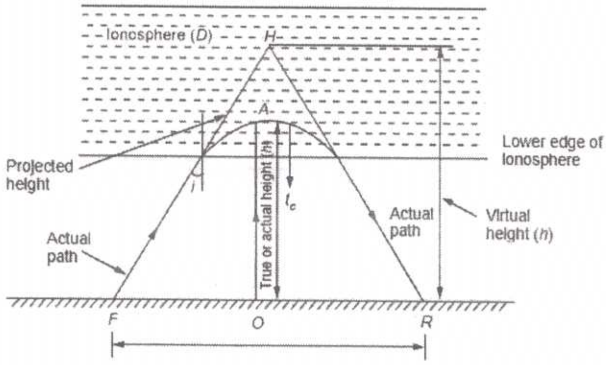
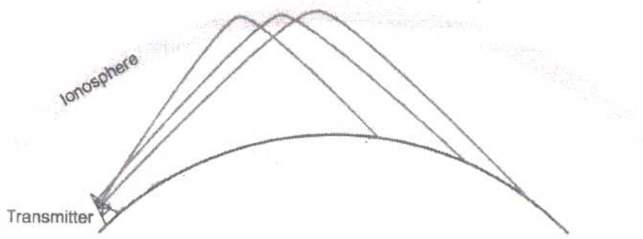
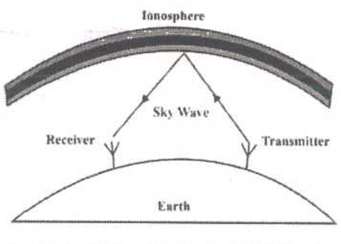
Scoring Indicators

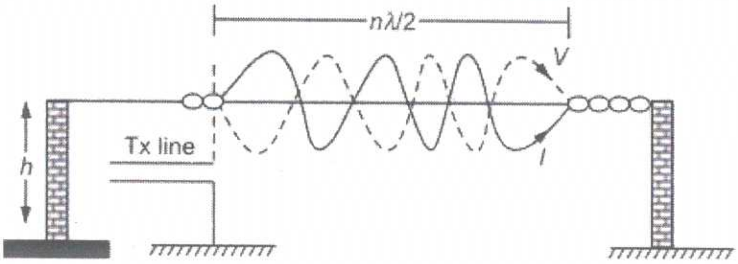
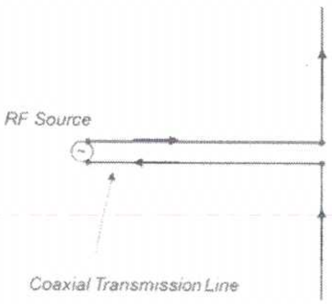
Revision : **2021** **QID** : **2102240177**

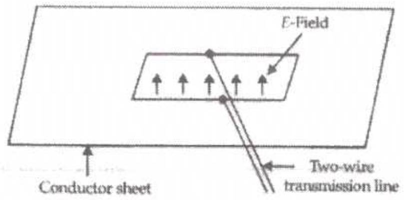
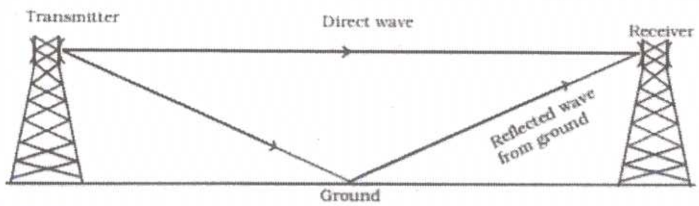
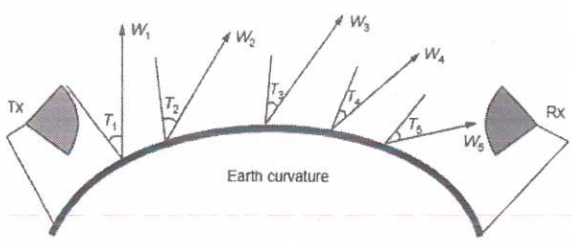
Course Title : **Antenna and Wave Propagation**

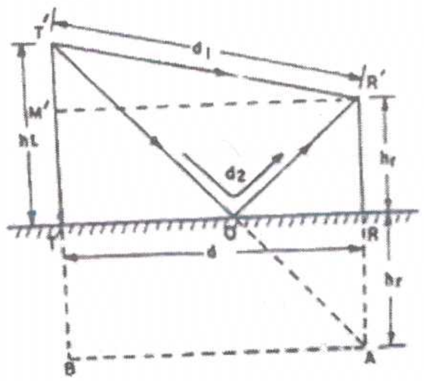
Course Code : **6201A**

Question No.	Scoring Indicator	Split Score	Sub Total	Total
	PART A			**9**
I 1	Ground wave propagation, Space wave propagation, Sky wave propagation	0.5*2 (any 2)	1	
I 2	Sky wave propagation	1	1	
I 3	$f_c = 9\sqrt{N_m}$	1	1	
I 4	D, E, F1, F2	0.5*2 (any 2)	1	
I 5	Fading is the fluctuation in the received signal strength.	1	1	
I 6	Antenna	1	1	
I 7	Short dipole antenna, dipole antenna, loop antenna, mono pole antenna	0.5*2 (any 2)	1	
I 8	Circularly	1	1	
I 9	Point-to-point communication, Remote sensing, Satellite communication, Deep-space telemetry, Radio and TV broadcasting, Radar systems, Wireless data links	0.5*2 (any 2)	1	
	PART B			**30**
II 1	• Ground waves are unaffected by any variation in atmospheric condition. • Ground waves are used to communicate between two points by giving enough power to them, • Ground waves are vertically polarized in order to prevent short circuit of electric field components. • Large wavelength causes less attenuation. • Ground waves bend around the corners during propagation which makes them more efficient.	1*3 (any 3)	3	

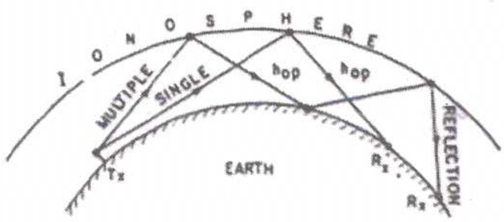
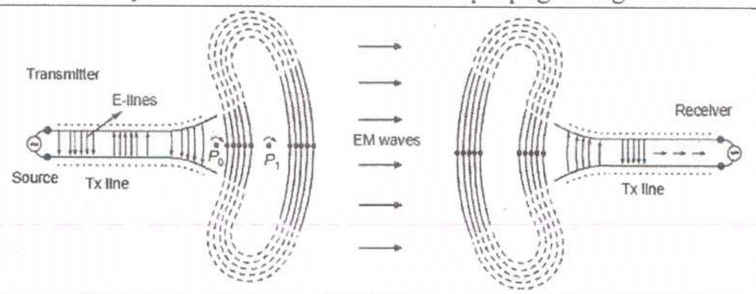
II 2		2	3	
	Virtual height is a height to which a wave sent vertically upward and travelling with the speed of light would reach taking the same two ways travel time as does the actual wave reflected from the layer.	1		
II 3		3	3	
II 4	**Space Diversity**: Replica of same signal is transmitted through different antenna. **Time Diversity:** Time diversity is obtained by re-transmitting the same signal at separate interval of time. **Frequency Diversity:** Frequency diversity is obtained by transmitting the same information on more than one carrier frequency. **Polarization Diversity:** Polarization diversity requires two transmitter and two receiving antennas with different polarization. **Angular Diversity**: This diversity allows the identical antennas to be located at same location but with a different pattern.	1.5*2 (any 2)	3	
II 5		2	3	

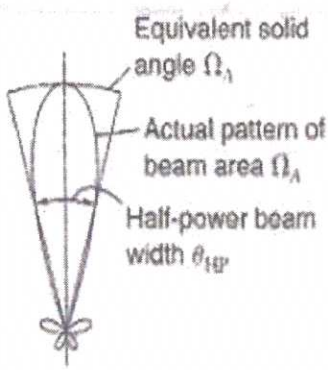
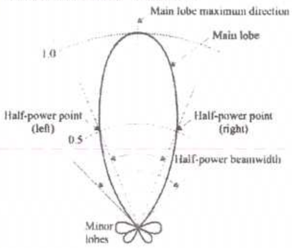
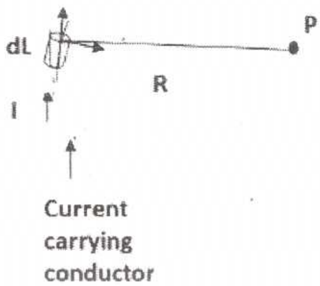
	Ionosphere acts as a reflecting surface. Due to the absorption of ultraviolet rays, cosmic rays, and other high energy radiations like α, β rays from sun, the air molecules in the ionosphere get ionized. This produces charged ions and these ions provide a reflecting medium for the reflection of radio waves back to Earth within the permitted frequency range. Thus the sky waves undergo total reflection and reach the ground.	1		
II 6	Radiation resistance describes the component of antenna resistance that accounts for the power radiated into space. It is the ratio of radiated power to the square of the current.	1.5	3	
	Radiation efficiency is the ratio of the total power radiated by the antenna to the net power accepted by the antenna.	1.5		
II 7		2	3	
	Resonant long wire antenna is not terminated. So standing waves exist because of mismatching of impedances and the radiation pattern becomes bidirectional corresponding to incident and reflected waves.	1		
II 8		3	3	
II 9	• Compact, low profile and light weight • Cheap • Easily developed • Thin and planar structure • Compatible with feed and matching network • Mountable on missiles, rocket and satellites	0.5*6 (any 6)	3	

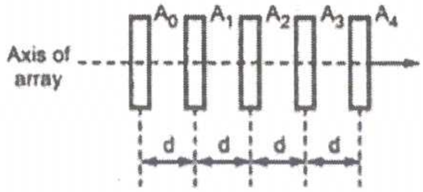
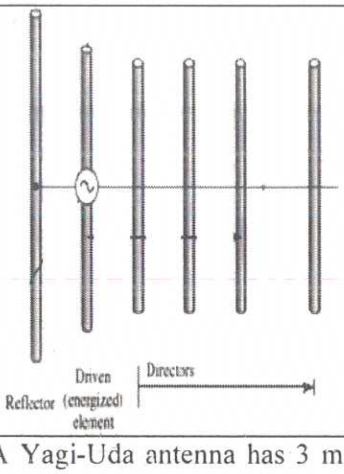
II 10		2	3	
	Slot antenna is with an opening cut in a metallic conductor which is excited using a two-wire transmission line or coaxial cable.	1		
	PART C			**42**
III		4	7	
	Space waves propagate in the frequency range of 30 MHz to 300 MHz. The space wave follows two paths from the transmitting antenna to the receiving antenna - one directly to the receiving antenna and the other reflected from the ground to the receiving antenna. Field strength at the receiver is the resultant sum of these two components.	3		
IV		4	7	
	Tilting of surface waves gradually increases as the wave propagates along the curvature of earth. This increase in the tilt of wave causes more short circuits of the electric field components and hence the field strength goes on reducing, as a result surface wave dies at the certain distance.	3		

<table>
<tr><td>V</td><td>
</td><td>4</td><td>7</td><td></td></tr>
<tr><td></td><td>$(h_t - h_r)^2 + d^2 = d_1^2$
$d_1 = d + \frac{(h_t + h_r)^2}{2d}$
$d_2 = d + \frac{(h_t + h_r)^2}{2d}$
Path difference between direct and reflected rays is,
$P \cdot d = d_2 - d_1$
$P \cdot d = \frac{2 h_t h_r}{d}$
Phase difference $(\alpha) = \frac{2\pi}{\lambda}$ (Path difference)
$\alpha = \frac{4\pi h_t h_r}{d\lambda}$ radians
Phase difference due to reflection from ground, $\beta = 180^0$
Total phase difference,
$\theta = \alpha + \beta$
Field strength at receiver,
$E_R = E_0 [1 + k(\cos\theta - j\sin\theta)]$
$|E_R| \cong \frac{88\sqrt{P}\, h_t h_r}{\lambda d^2}$ volt/metre
Thus field strength is inversely proportional to square of the distance.</td><td>3</td><td></td><td></td></tr>
<tr><td>VI</td><td>According to the Sommerfield Equation, Electric field strength E at a distance from transmitting antenna due to ground wave, is given by
$E = 120\pi h_t . h_r . I_s / \lambda . d$ (volt/meter)
where, 120π – Intrinsic impedance of free space
ht , hr – Effective heights of transmitting and receiving antennas
Is – Antenna currents
d – Distance between TX and RX antennas
λ – Wavelength

Thus the filed strength depends on frequency, conductivity of earth, dielectric characteristics of ground, antenna height, antenna current and transmission distance.</td><td>7</td><td>7</td><td></td></tr>
</table>

VII	The highest frequency, which can be reflected back to earth only at a specific angle of incidence rather than the vertical, is known as maximum useable frequency (MUF).	2	7	
	The skip distance is the distance from the transmitter to a point where the waves first return to earth after reflection from the ionosphere.	2		
	The relation between MUF and skip distance is $$D_{skip} = 2h\sqrt{\left(\frac{f_{MUF}}{f_c}\right)^2 - 1}$$ where h = height of ionospheric layer f_c = critical frequency of the layer	3		
VIII		4	7	
	In the frequency range 2MHz –30MHz, the sky waves are reflected back towards the earth by ionosphere. This form of propagation is relatively unaffected by the Earth's surface and can propagate signals over long distance.	3		
IX		4	7	
	The radiation from the antenna takes place when the Electromagnetic field generated by the source is transmitted to the antenna system through the Transmission line and separated from the antenna into free space.	3		
X	Principle of reciprocity states that if an emf is applied to the terminals of Antenna 1 (Tx) and current is measured at the terminals of Antenna 2 (Rx), then an equal current (in both amplitude and phase) would be observed at the terminals of Antenna 1 (Tx) in case the same emf is applied to the terminals of antenna 2 (Rx). Assumptions are: (i) The values of emf should have the same frequency, and the media between Tx and Rx need to be linear, passive and isotropic. (ii) Generator and ammeter need to have either zero or equal impedance.	4	7	

<table>
<tr><td></td><td>(iii) There should be polarization matching between Tx and Rx.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>A transmitter connected to antenna 1 is generating a current I_1 at antenna 1 and is inducing an emf E_{21} at antenna 2.
A transmitter connected to antenna 2 is generating a current I_2 at antenna 2 and is inducing an emf E_{12} at antenna 1.
According to principle of reciprocity,
$E_{21} = E_{12}$ if $I_1 = I_2$</td><td>3</td><td></td><td></td></tr>
<tr><td>XI</td><td>The beam area or beam solid angle Ω_A is defined as the solid angle through which all the power of the antenna would flow if its radiation intensity is constant. It is given by the integral of the normalized power pattern over a sphere.

</td><td>3.5</td><td>7</td><td></td></tr>
<tr><td></td><td>Half power beam width is the angular width in degrees measured on the radiation pattern between points where the radiated power has fallen to half its maximum value.

</td><td>3.5</td><td></td><td></td></tr>
<tr><td>XII</td><td>
</td><td>4</td><td>7</td><td></td></tr>
</table>

	The retarded potentials are the electromagnetic potentials at the observation point produced by the time varying electric current or charge distributions at source point in an earlier time. Consider an element dl carrying a current I. The effect of the current flow is not observed at a distant point P at the same time, but only after a delay which is equal to the time needed for the electromagnetic waves to reach that distant point. P is at a distance of R from element and the electromagnetic waves are travelling at the velocity of light, c. So the time taken to reach P is R/c. The potential developed at a distant point P at time, t is due to the current flowing in element dl at an earlier time t-R/c. This potential is known as retarded potential.	3		
XIII		4	7	
	Linear array is an array in which individual elements are equally spaced along a straight line. The elements are generally λ/2 long dipoles. They can achieve high gain, high directivity and high signal to noise ratio.	3		
XIV		4	7	
	A Yagi-Uda antenna has 3 main elements – a driven element, a reflector and one or more directors. The driven element is a half wave dipole. The 3 elements are arranged collinearly. Reflector length is more than that of driven element and director length is less than that of driven element.	3		