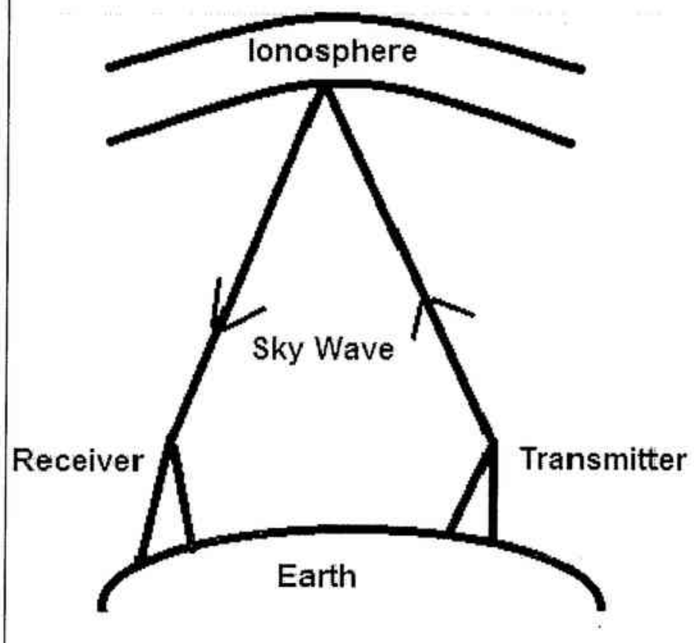
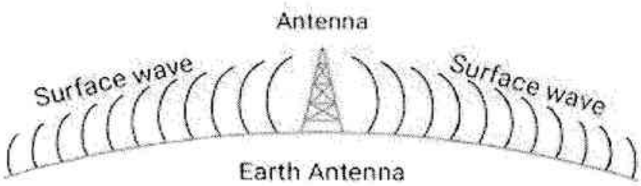
SCORING INDICATORS

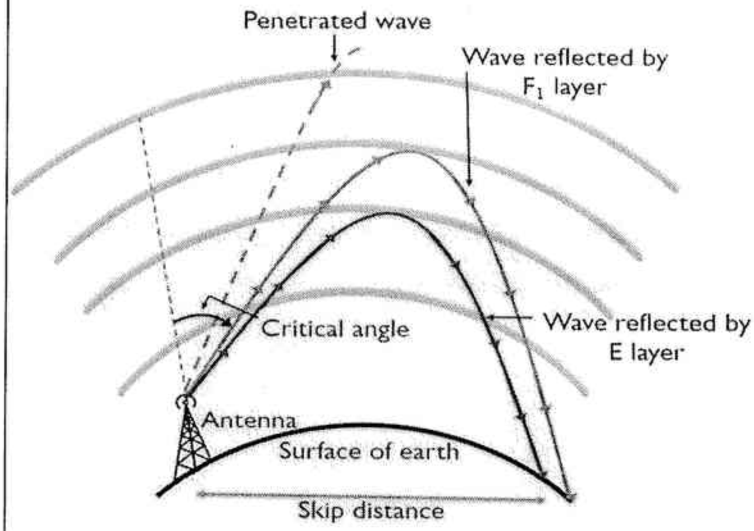
COURSE NAME: ANTENNA AND WAVE PROPAGATION
COURSE CODE: 6201A QID: 2102240179

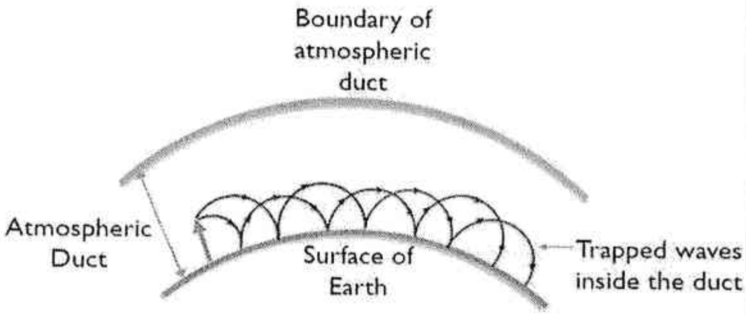
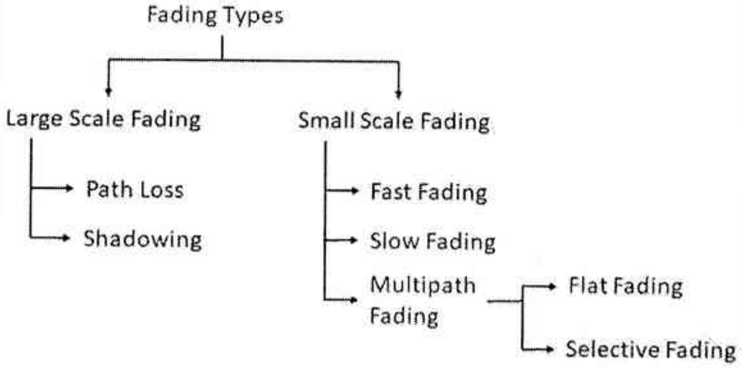
QNo	ScoringIndicators	Split score	Sub Total	Total score
	PARTA			**9**
I.1	Ground wave propagation, Sky wave propagation, Space wave propagation	1	1	9
I.2	Line of sight	1	1	
I.3	The path of incident wave and reflected wave are same if it is reflected from a surface located at a greater height of this layer. Such a greater height is termed as virtual height.	1	1	
I.4	Critical frequency	1	1	
I.5	The high frequency waves travel by multiple reflections off the ionosphere (F layer) and off the earth just like multihops.	1	1	
I.6	The ratio of the intensity, in a given direction, and the radiation intensity that would be obtained if the power accepted by the antenna were radiated isotropically	1	1	
I.7	Near field region.	1	1	
I.8	Aircraft, spacecraft, satellite, missile, mobile radio, and wireless communications	0.5 + 0.5	1	
I.9	Folded dipole, halfwave dipole	0.5+ 0.5	1	
II.1	1. As it uses lower frequencies, interference occurs due to atmospheric noise only. 2. These waves are more efficient and also these are not affected by the change in atmospheric conditions, due to the bending around the corners or obstructions during propagation. 3. They are vertically polarized in order to prevent short circuits of the electric field (E) component. *(Any three)*	1 x 3	3	

II.2	The path or direction along which wave energy propagates through the earth. In isotropic media, the raypath is perpendicular to the wavefront. The raypath can be calculated using ray tracing. Critical frequency is the highest magnitude of frequency above which the waves penetrate the ionosphere and below which the waves are reflected back from the ionosphere. It is denoted by "f_c".	1.5+1.5	3	
II.3	The ionosphere is usually thought of as an area where radio waves on the short wave band are refracted of reflected back to the earth. However it is also found that the signals are reduced in strength or attenuated as they pass through this area. Ionospheric absorption (ISAB) is the scientific name for absorption occurring as a result of the interaction between various types of electromagnetic waves and the free electrons in the ionosphere, which can interface with radio transmissions.	3	3	
II.4	Critical frequency is the highest frequency that gets reflected back to the earth when it is aimed straight up at the ionosphere However, as the angle of incidence decreases the reflected frequency increases. MUF (Maximum Usable Frequency) is the maximum frequency which can be reflected for given distance of transmission. MUF is usually 3 to 4 times of critical frequency. MUF = critical frequency/cos θ Skip distance is the distance a radio wave travels, usually including a hop in the atmosphere. A skip distance on the earth's surface between the two points.	3	3	
II.5	Skywave propagation refers to the propagation of radio waves reflected or refracted back toward earth from the ionosphere, an electrically charged layer of the upper atmosphere. Since it is not limited by the curvature of the Earth, skywave propagation can be used to communicate beyond the horizon, at intercontinental distances. It is mostly used in the shortwave frequency bands.			

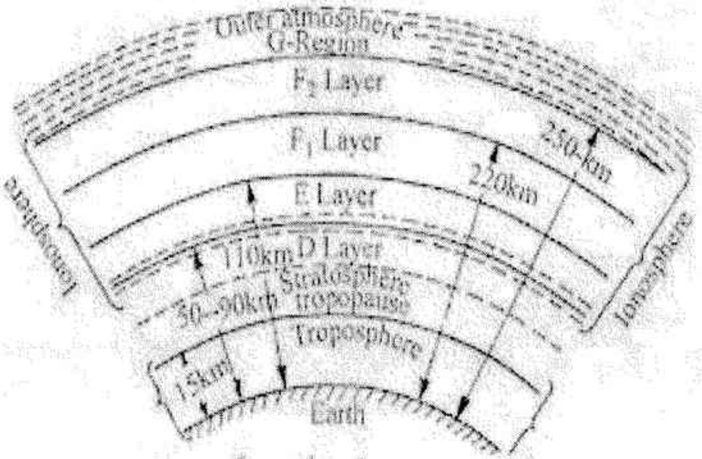
	 Figure *(1.5 marks)* + *Explanation (1.5 marks)*	1.5+1.5	3	
II.6	1. Radio and Television signal transmission 2. GPS and navigation system 3. Satellite communication 4. Remote sensing 5. Biomedical applications etc. *(any three)*	1 x 3	3	
II.7	• Easy to fabricate, modify, and customize. • Simple and inexpensive construction. • Lightweight and low volume. • Suitable for array antennas. • Conformity with planar and non-planar surfaces. • Mechanical robustness. • Compatible with monolithic microwave integrated circuits. *(any three)*	1 x 3	3	
II.8	Specialized normal-mode helical antennas are used as transmitting antennas for FM radio and television broadcasting stations on the VHF and UHF bands. Compared to the monopole, which is essentially a two-dimensional structure, the helical antenna is a 3-dimensional structure but	1 x 3	3	

	is nothing else as a "shorter quarter- wave". Its radiation pattern is similar in nature to the monopole. This provides an optimum condition for portable communications. A helical antenna consists of a conductor wound into a helical shape and connected to a ground plane			
II.9	A half-wave dipole, also known as a doublet, or the Hertz antenna, is the most commonly used type of dipole antenna. The length of its conductive elements is approximately half of the maximum wavelength (λ/2, the distance between two consecutive maximum or minimum points) in free space at the frequency of operation	3	3	
II.10	**1.** Arrays can be used to achieve higher gain. **2.** To give path diversity (also called MIMO) which increases communication reliability. **3.** To cancel interference from specific directions. **4.** To steer the radio beam electronically to point in different directions. **5.** For radio direction finding (RDF). *(any three)*	1 x 3	3	
III	→ The process in which radio frequency waves propagates along the surface of the earth for the communication purpose. → Low frequency of electromagnetic spectrum is used. → Also called surface wave propagation. → Collection of these radiations along the surface of the earth is known as ground wave propagation. → Intensity of radiations drops with distance due to its absorption by ground.  *Fig (3 marks) + Expln. (4 marks)*	3 + 4	7	7

IV	Sky waves are electromagnetic waves transmitting antennae emit and then receive after being reflected by the ionosphere. This method of propagation is known as sky wave propagation. The ionosphere's entire internal reflection of the electromagnetic waves causes the skywaves to propagate, sky wave propagation, also known as ionospheric propagation, is the mode of propagation in which electromagnetic waves emitted from an antenna and directed upward at great angles are reflected back to earth by the ionosphere.  *Fig (3 marks) + Expln. (4 marks)*	3 + 4	7	
V	Ground waves are divided into three components: surface waves, direct waves, and earth reflected waves. The factors that affect ground wave propagation are the nature of the ground, weather, polarization, and signal frequency. (i)nature of the source (ii) direction of propagation. (iii) motion of the source and/or observer. (iv) wavelength (v) intensity of the wave. When the waves propagates near to the surface, the waves glide over the surface of the earth, they are called ground. Waves. The maximum range of coverage depends on the transmitted power and frequency.	7	7	

VI	Duct propagation occurs when a layer of warm air is trapped between two layers of cooler air, creating a duct that can guide and propagate radio waves over long distances. Atmosphere ducting is the mode of propagation of electromagnetic radiation usually in the lower layer of the earth's atmosphere where the wave is bent by atmospheric reflection. The microwave signal is propagating along the curvature of the earth is known as ducting. Duct propagation allows the signals to pass beyond the horizon, unlike the usual line of sight propagation of VHF and UHF frequencies. The atmospheric duct in case of duct propagation acts like a natural waveguide in the atmosphere, which guides radio waves along the curvature of the earth.  *Figure (3 marks) + Expln (4* marks)	3 + 4	7	
VII	Fading is a phenomenon in which the strength and quality of a radio signal fluctuate over time and distance. Fading is caused by a variety of factors, including multipath propagation, atmospheric conditions, and the movement of objects in the transmission path.  			

	Small Scale Fading • Small-scale fading is a common issue in wireless communication. • It happens when a signal is transmitted from a transmitter to a receiver and it experiences multiple signal paths due to reflection, diffraction, and scattering from objects in the environment. • These signal paths can cause interference and distortion to the signal, resulting in fluctuations of the signal strength at the receiver. • Small-scale fading is called "small-scale" because the variations occur over short distances, such as a few centimeters to a few meters. • Small-scale fading can happen very quickly, sometimes in microseconds or less. • It is primarily caused by the multipath propagation of the signal. **Large scale fading** • Large-scale fading is a phenomenon that occurs in wireless communication when the signal strength decreases over long distances. • Large-scale fading is called "large-scale" because the variations occur over long distances, typically several kilometers. • Unlike small-scale fading, which affects individual symbols or bits, large-scale fading affects the entire signal. • Large-scale fading is a slow-varying phenomenon, meaning that it changes over time scales of seconds to minutes. • Mitigation techniques for large-scale fading include power control, antenna placement, repeaters, and site diversity.	1+3+3	7	

<table>
<tr><td>VIII</td><td>The ionosphere is located within the thermosphere and extends from 37 to 190 miles (60-300 km) above the Earth's surface. It is divided into three regions or layers: the F-Layer, E-Layer, and D-Layer. During the daytime, the F-Layer splits into two layers, then recombines at night.
The ionosphere is broken down into three regions or levels: the D, E and F-levels. These three layers are important for radio and telecommunications as the ionosphere reflects these waves. The D-region does not stay charged and returns to neutral at night


Ionosphere Layers
Fig(4 marks) + Expln(3 marks)</td><td>4 + 3</td><td>7</td><td></td></tr>
<tr><td>IX</td><td>An antenna radiation pattern (or antenna pattern) is defined as a mathematical function or a graphical representation of the radiation properties of the antenna as a function of space coordinates. An antenna's radiation pattern and gain describe how symmetrically it radiates or absorbs electromagnetic radiation, depending on whether it is transmitting or receiving. These parameters are usually given for the frequencies at which the antenna is designed to operate, as they can vary with frequency</td><td></td><td>7</td><td></td></tr>
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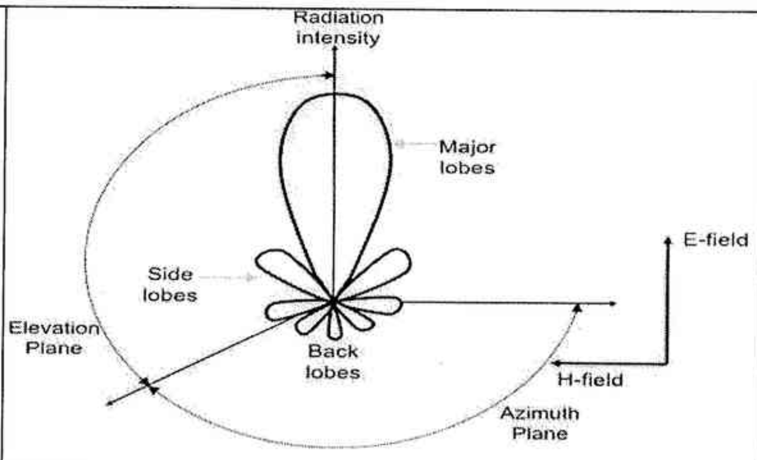
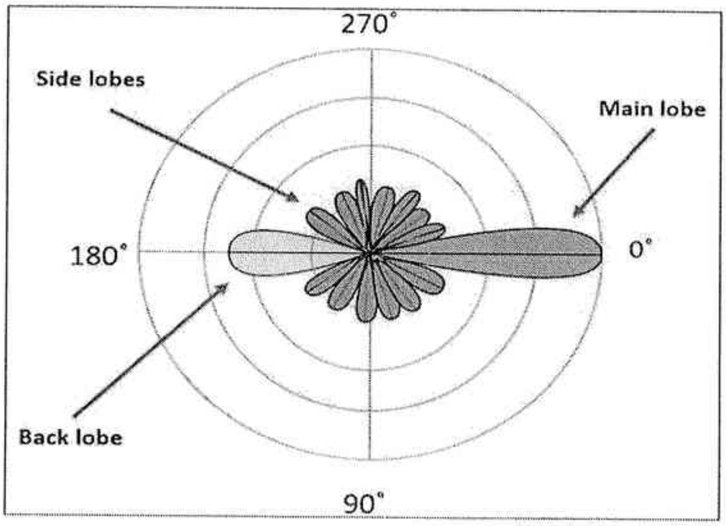
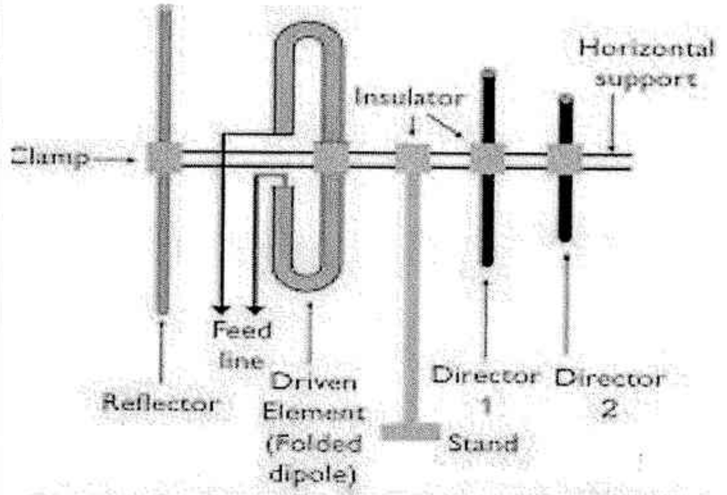
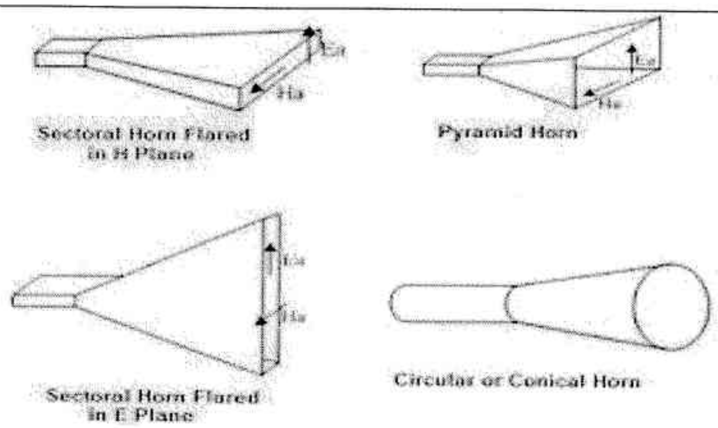
				
X	1. Signal power to noise power at the same point. 2. Beamwidth is the angular separation between the points in the main lobe that are down from the maximum gain by 3 dB 3. The value of electrical resistance that would dissipate the same amount of power as heat, as is dissipated by the radio waves emitted from the antenna 4. The ratio of radiation intensity in a particular direction to the average radiated power. G_d does not depend upon the power input to the antenna & its ohmic losses. The maximum value of directive gain is the directivity D of the antenna.	1+2+2+2	7	
XI	The duality principle enables one to express the fields radiated by an electrically small loop antenna in terms of the fields available for an electrically small dipole antenna. Antenna radiates by the principle of resonance. Resonance implies maximum standing current wave is observed along the antenna length. A simple dipole antenna has two antenna rods pointing in opposite directions but remains parallel. The duality of an antenna specifies a circuit device on one band and a space device on the other hand.			

XII	Effective aperture is the ratio of the available power at the terminals of the antenna to the power flux density of a plane wave incident upon the antenna which is polarization matched to the antenna. The effective antenna aperture/area is a theoretical value which is a measure of how effective an antenna is at receiving power. The effective aperture/area can be calculated by knowing the gain of the receiving antenna. The radiation pattern or antenna pattern is the graphical representation of the radiation properties of the antenna as a a function of space. That is, the antenna's pattern describes how the antenna radiates energy out into space (or how it receives energy). The energy radiated by an antenna is represented by the **Radiation pattern** of the antenna. Radiation Patterns are diagrammatical representations of the distribution of radiated energy into space, as a function of direction.  *3.5 marks each*	3.5 + 3.5	7	
XIII	Yagi–Uda antennas consist of a single driven element connected to a radio transmitter or receiver (or both) through a transmission line, and additional passive radiators with no electrical connection, usually including one so-called reflector and any number of directors. It works by having a radiating element that serves as the antenna's main radiation source and parasitic elements that act as reflectors and			

	directors. The position of the reflector is behind the main element and reflects the signal back to the driven element.  Structure of Yagi-Uda Antenna *Fig(4 marks) + Expln(3 marks)*	4 + 3	7	
XIV	 A horn antenna is used to transmit radio waves from a waveguide (a metal pipe used to carry radio waves) out into space, or collect radio waves into a waveguide for reception. The horn's shape serves to direct and focus the radiated energy into a specific direction, increasing the antenna's directivity and gain. Radio waves are collected by the large bottom surface, which is parabolically curved and reflected upward at 45° angle. After hitting top surface, they are reflected to the focal point. The gain and beam width of these are just like parabolic reflectors. *Figure (3 marks) + expln. (4 marks)*	3 + 4	7	