PROPAGATION AND ANTENNA
ENEX 303

Year/Part: III/I

Teaching Schedule				Examination Scheme						Total
				Theory			Practical			
L	T	P	Total	Assessment Marks	Final		Assessment Marks	Final		
					Duration (Hrs)	Marks		Duration (Hrs)	Marks	
3	1	1.5	5.5	40	3.0	60	25	0	0	125

Depth Codes

E-Explanation	C-Circuit	D-Definition	DM-Demonstration
DV-Derivation	SD-Symbolic Diagram	P-Proof	I-Illustration
NUM-Numerical	DR-Drawing	S-State	ACT-Activity-based Learning
MP- Mini Project	EXP-Experiment	REV-Review / Recap	PS- Problem Solving
QA- Question Answer	Q- Quiz	ST- Surprise Test	MT-Mid Term Test

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
1	Wave Propagation and Antenna Fundamentals			**6**	**1.5**		**1**
	1.1 Radiation Phenomena in a Conductor	D, E	Definition of Radiation, Electric Current, Release of RF Energy,	0.25			
	1.2. Function of Antenna	E, DM, SD	Definition of Antenna Phenomena, Benefits, Application of Antennas in Communication System, Symbolic block diagram,	0.5			
	1.3. Retarded Potentials: EM Wave Generation and Propagation	E, DV, DR	Explanation, Necessary Drawing/Diagrams , Derivation of Retarded Vector and Scalar Potentials,	1	1		
	1.4 Radiated Electric and Magnetic Fields in EM Wave	E, DR,	Explanation of Electric and Magnetic Fields in the direction of Wave Propagation	0.25			
	1.5 Radiation Patterns and Input Impedance of Very Short Dipole, Short Dipole and Long Dipoles	E, D, DR, SD	Explanation of Radiation Patterns, Definition of Input Impedance, Different Dipoles,	0.5		2	
	1.6 Antenna Theorems						2
	1.6.1 Reciprocity Theorem	E, I, DR	Explanation, State with Suitable Illustrations	0.5			
	1.6.2 Superposition Theorem	E, I, DR	Explanation, State with Suitable Illustrations	0.5			
	1.6.3 Thevenin Theorem	E, I, DR	Explanation, State with Suitable Illustrations	0.5			
	1.6.4 Maximum Power Transfer Theorem	E, I, DR	Explanation, State with Suitable Illustrations	0.5	1		
	1.6.5 Compensation Theorem	E, I, DR	Explanation, State with Suitable Illustrations	0.5			
	1.6.6 Equality of Directional Patterns	E, I, DR	Explanation, State with Suitable Illustrations	0.5			
	1.6.7 Equivalence of Receiving and Transmitting Impedances	E, I, DR	Explanation, State with Suitable Illustrations	0.5			
	Evaluation	QA, Q					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
2	Basic Antenna Parameters and Arrays			**7**			**3**
	2.1. Antenna Parameters	E, I, S, DM,DR, DV	Definition of Basic Antenna Parameters: EIRP, Gain, Directivity, PFD, Receiving Power Intensity, Band widths, Beam Width, Polarization……	2	1	2	
	2.2. Pattern Multiplications	D, E, I	Antenna Patterns Importance, Benefits, Methods, Types etc….	1			
	2.3 Two Dimensional Antenna Arrays					2	4
	2.3.1 Broadside Arrays	E, I, SD	Criteria to make the Arrays, Applications,	0.5	1		
	2.3.2 End Fire Arrays	E, I, SD	Criteria to make the Arrays, Applications,	0.5			
	2.3.3 Parasitic Arrays	E, I, SD	Criteria to make the Arrays, Applications,	0.5			
	2.3.4 Collinear Arrays	E, I, SD	Criteria to make the Arrays, Applications…	0.5			
	2.4 Arrays of Two Point Sources						
	2.4.1 With Equal Amplitude and Same Phase	E, DV, NUM	Apply of Exponential Formula, Derivations	0.5			
	2.4.2 With Equal Amplitude and Opposite Phase	E, DV, I NUM	Apply of Exponential Formula, Derivations	0.5			
	2.4.3 With Equal Amplitude and Quadrature Phase	E, DV, I	Apply of Exponential Formula, Derivations	0.5			
	2.4.4 With Any Amplitude and Any Phase	E, DV, I	Illustration and Derivations only	0.5			
	Evaluation	AQ, Q					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
3	Antenna Classifications			**12**			**5**
	3.1. Electromagnetic Spectrum	E, I	Definition of Electromagnetic Spectrum, Illustration	0.5			
	3.2. Criteria for Antenna Design	E, I	Features of Antennas, Can any metal be an Antenna? How…?	1	1		
	3.3 Isotropic Antenna	E, I, DR	Major Features of Isotropic Antennas, Suitable Illustrations	0.5			
	3.4 Omnidirectional Antennas	E, I, DR	Major Features of Omnidirectional Antennas, Suitable Illustrations	0.5		1	
	3.5 Directional Antennas	E, I, DR	Major Features of Directional Antennas, Suitable Illustrations	0.5		1	
	3.6 Travelling and Standing Wave Antennas: Long Wire Antenna, Vee Antennas, Rhombic Antenna	E, I, DR,	Explanations, Illustrations, Terminated and Non-terminated Long Wire Antenna, Vee Antennas, Rhombic Antenna, Working Functions, Constructions and Applications	2	1	2	6
	3.7 Wired Antennas: Monopole and Dipole Antennas, Yagi-Uda Antenna, Log-periodic Antenna, Loop Antenna, Helix Antenna	E, I, DR, NUM	Explanations, Illustrations of Wire Antennas, Comparison between Monopole and Dipole Antennas, Yagi-Uda Antenna, Log-periodic Antenna Design Concepts, Loop Antenna, Helix Antenna's Different Modes of Operations, Constructions and Applications	2		2	
	3.8 Reflector Antennas: Small Plane Sheet and Large Plane	E, I, DR,	Explanations, Illustrations of Reflector Antennas, Comparison between Small	2	1	1	7

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
	Sheet; Linear and Corner Types		Plane Sheet and Large Plane Sheet; Linear and Corner Types, Plane Reflector Antenna's Operations, Constructions and Applications				
	3.9 Aperture Antennas: Horn Antennas Types, Parabolic Antenna Types	E, I, DR,	Explanations, Illustrations of Aperture Antennas, Comparison between Different Horn Antennas and Parabolic Antennas, Symmetric and Asymmetric Reflector Antennas, Single, Dual and Multi-Reflector Antennas' Construction and Applications	2	1	1	8
	3.10 Advanced Antennas: Microstrip Antenna and Smart Antennas	E, I, DR,	Explanations, Illustrations of Advanced Antennas, Microstrip Antenna and Its Arrays and Smart Antennas' Construction and Applications	1		1	
	Evaluation	AQ, Q					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
4	Propagation and Radio Frequency Spectrum			**7**			**9**
	4.1. Radio Frequency Spectrum	E, I,	Definition of Radio Frequency Spectrum (Characteristics, Simple Illustration)	0.5			
	4.2. Ground Wave	E, I, DR	Features of Surface wave, Function, Benefits, Applications, Antennas used	1			
	4.3 Ground Reflected Wave and Duct Propagation	D, E, I. DR	Features of Ground Reflected Wave, Function, Benefits, Applications, Definition of Duct Propagation	1			
	4.4 Space Wave	D, E, I. DR	Features of Direct wave, Function, Benefits, Applications, Antennas used	1			10
	4.5 Sky Wave and Ionospheric Layers	D, E, I. DR	Features of Sky wave, Function, Benefits, Applications, Characteristics and Illustration of Different Ionospheric Layers	1			
	4.6 Maximum Usable Frequency (MUF)	D, E, I. DR,DV, NUM	Definition of Maximum Usable Frequency, Measurement, Characteristics of MUF	1	1		
	4.7 Critical Frequency (f_{CRT}) and Skip Distance (D)	D, E, I. DR,DV, NUM	Definition of Critical Frequency (f_{CRT}), Measurement of Skip Distance, Relations between them when Earth is Curved or Not	1.5	1		11
	Evaluation	AQ, Q					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
5	Propagation between Antennas			**6**			
	5.1. Propagation of Radio Waves	E, I, DM	Definition of Radio Waves and Band Allocation in Radio Frequency Spectrum	0.25			

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
	5.2. Propagation Characteristics of Different Band of Frequencies	E, I	Explanation of Radio Frequency Bands and their Characteristics and Applications	1			12
	5.3 MW, SW, VHF, UHF and SHF Band Characteristics	E, I	Characteristics of Given Radio Frequency Bands and their Importance, Applications, Antennas	2	1		
	5.4 Propagation Models: Free Space, Two-ray and Multi-path Models	E, I. DR, DV	Characteristics of Propagation Models, and their Importance, Applications Areas.	1.25	1		
	5.5 Free Space Propagation	E, DR, DV	Major Features of Free Space Propagation, Line of Sight (LOS)	0.5			13
	5.6 Fresnel Zones and Knife Edge Diffraction	E, DR, DV	Major Features of Fresnel Zones, and Knife Edge Diffraction, LOS and NLOS Communications	1			
	Evaluation	AQ, Q					

Unit	Topic/ Sub topic	Depth Code	Description of Depth	Actual plan			Week
				L	T	P	
6	Link Budget			**7**			
	6.1. Introduction	D, I	Explanation of Link Budget, Obtaining Formulas for Uplink and Downlink Budget	0.5			
	6.2. Friis Transmission Equation	E, DV	Obtaining Formulas for Uplink and Downlink Budget using Friis Transmission Equation	1			
	6.3 EIRP and Free Space Loss Calculation	E, DV, NUM	Use of EIRP and Free Space Loss in Link Budget Calculation	1	1		14
	6.4 Link Budget Calculations 6.4.1 Uplink Calculation 6.4.2 Down-link Calculation	E, DR, DV, NUM	Application of Formulas of Uplink and Downlink Calculations with suitable Illustrations	4.5	2		15
	Evaluation	AQ, Q					

References: (Primarily based on the syllabus, and relevant chapters may be consulted as needed)

1. Kraus, J. D. (1950). Antenna (Latest Edition). McGraw-Hill.
2. Balanis, C. A. (2016). Antenna theory: Analysis and design. John Wiley & Sons.
3. Collins, R. E. (1985). Antennas and radiowave propagation (Latest Edition). McGraw-Hill.
4. Gautam, A. K. (2010). Antenna and wave propagation. S. K. Kataria & Sons.

Model Question

PROPAGATION AND ANTENNA

ENEX 301

Year/Part: III/I

QN	Question	Marks	Unit
1	Define an antenna. Show the current distribution and radiation patterns of λ/4 antenna and λ/2 dipole antenna; explain their field of applications in the communication systems.	4	1
2	Explain the generation of retarded potential at a distance, r from the point source, P and write its retarded scalar and vector potential expressions.	4	1
3	List the antenna theorems. Explain on the reciprocity theorem and compensation theorem.	4	1
4	Derive the expression and plot its total radiation field pattern of an array of two isotropic point sources having equal amplitude and quadrature phase difference with spacing between them (d) is λ/4.	5	2
5	Define following antenna parameters: i) Antenna gain ii) Polarization	4	2
6	Design a five element Yagi-Uda antenna which can receive VHF television signal band of 148 MHz to 154 MHz. Take driven element length 0.48 λ_c having spacing between two elements is 0.15λ_c.	5	3
7	List major features of rhombus antenna and show radiation patterns for both terminated and non-terminated conditions.	5	3
8	Write short note on ionospheric wave. Find out the relationship between the critical frequency (f_{crt}) and skip distance (D) if it is considered that distance between the transmitting and receiving antennas on the curved Earth surface.	7	4
9	a) Explain the major characteristics of MW and UHF propagation. b) Describe two-ray propagation model with necessary derivations and diagrams	4 3	5 5
10	A 125 W transmitter connected with 2.6 m diameter parabolic antenna having 76 % antenna efficiency with 1.8 dB waveguide loss for transmitting frequency range of 6265 MHz to 6301 MHz band propagating for 1250 Km far away microwave receiver, if the receiving antenna diameter is 4.2 m given with 84% antenna efficiency. What will be the receiving antenna gain and path loss for the uplink C-band communication system?	9	6
11	Write short notes (Any two): a) Friis transmission equation b) Cassegrain antennas c) Smart antenna d) Knife edge diffraction	6	2,3,4,6

Note: *Number of questions and distribution of marks are indicative only.*