Name: **Enrolment No:**	UPES UNIVERSITY OF TOMORROW

UPES

End Semester Examination, December 2023

Course: Antenna and Wave Propagation **Semester: V**

Program: B. Tech Electronics and Communication Engineering **Time: 03 hrs.**

Course Code: ECEG-3041 **Max. Marks: 100**

Instructions: answer all the questions

SECTION A

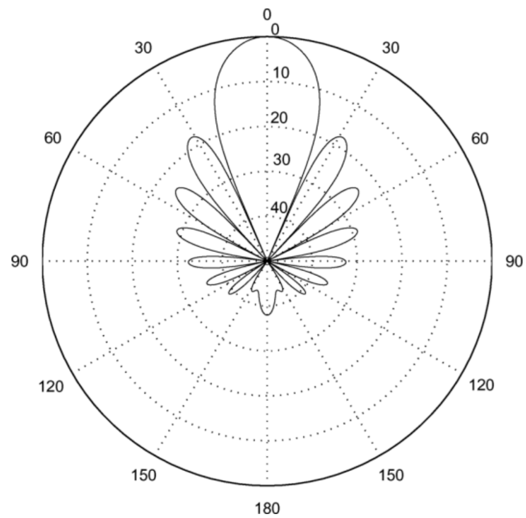
(5Qx4M=20Marks)

S. No.		Marks	CO
Q. 1	Define the following terms associated with the antenna. (a) Radiation pattern. (b) Power pattern. (c) Gain (d) Polarisation.	**4**	**CO1**
Q. 2	Derive a relationship between the gain and effective height of an antenna.	**4**	**CO2**
Q. 3	Calculate the directivity of a horn antenna having the following specifications: Operating frequency = 6 GHz. Aperture efficiency = 70% Dimension of the horn = 4 cm × 2.5 cm	**4**	**CO2**
Q. 4	Show that the gain of a quarter-wave dipole is 4.6 dB more than that of an isotropic antenna.	**4**	**CO2**
Q. 5	Describe with a diagram the process of the radiation of electromagnetic waves in free space from an antenna.	**4**	**CO3**

SECTION B

(4Qx10M= 40 Marks)

Q. 6	(a) An antenna element is formed by placing a folded dipole in between 2 parasitic elements. One of the elements is larger and the second one is smaller than the folded dipole. How does this combined structure help in having radiation in one direction and null in another? (b) Estimate the length of a Yagi Uda antenna, consisting of 9 elements, and operating at 40 MHz with the following specifications: Reflector length = 0.55 λ Interelement separator = 0.1 λ. Separation between driver and reflector = $\lambda/4$.	**6+4**	**CO2**

Q. 7	(a) A standard gain horn antenna with a power gain of 10 dB is used to measure the gain of a large directional antenna by comparison method. The test antenna is connected to the receiver and an attenuator is adjusted to 15 dB to have the same receiver output. Find out the gain of the large antenna. (b) The radiation pattern of an antenna is shown in the diagram. Determine the Front-to-back ratio, Half Power Bandwidth, First Null bandwidth, and no. of minor lobes. 	**5+5**	**CO3**
Q. 8	(a) Mention the salient features of horn antenna in terms of its significance in very high-frequency applications. (b) A paraboloid antenna is fed with a primary dipole antenna at 10 GHz of frequency. The diameter of the paraboloid antenna is 5λ. Calculate the following quantities. (i) Gain. (ii) Effective aperture (iii) FNBW	**10**	**CO2**
Q. 9	(a) What are the various ionospheric layers and provide a definition of the maximum usable frequency for ionospheric propagation. (b) A radio broadcasting link has to be established between New Delhi and Singapore with the help of propagation of radio waves through an ionosphere of height 300 km with a critical frequency of 50 MHz. The distance between the two aforesaid cities are 2500 km. Determine the maximum usable frequency for this specific transmission path.	**10**	**CO2**
SECTION-C (2Qx20M=40 Marks)			
Q. 10	(a) A rectangular patch is formed on the upper surface of a substrate with a dielectric constant of 4.4. The lower side of the substrate, whose height		

	is 1.6 mm, acts as a ground plane. The antenna is excited with a 50-ohm impedance source using a microstrip line. Calculate the dimensions and characteristic impedance of this antenna for a resonant frequency of 6 GHz. Use the following empirical formula for the calculation. $$L = \frac{c}{2f_r\sqrt{\varepsilon_{eff}}}$$ $$W = \frac{c}{2f_r}\sqrt{\frac{2}{(\varepsilon_r + 1)}}$$ $$\varepsilon_{eff} = \frac{\varepsilon_r + 1}{2} + \frac{\varepsilon_r - 1}{2}\left[1 + 12\frac{h}{W}\right]$$ $$L = L_{eff} - 2\Delta L$$ $$\Delta L = 0.4\, h \left\{\frac{(\varepsilon_{eff} + 0.3)\left(\frac{W}{h} + 0.26\right)}{(\varepsilon_{eff} - 0.26)\left(\frac{W}{h} + 0.8\right)}\right\}$$ $$Z_m = \frac{120\pi\, h}{W\sqrt{\varepsilon_r}}$$ (b) Explain the mechanism by which a microstrip antenna radiates electromagnetic waves into space using the transmission line model.	**10+10**	**CO4**
Q. 11	(a) When a radio wave is propagating in free space, it is encountered with transmission losses. Deduce the Friss transmission equation formula for the estimation of transmission losses. (b) An FM radio link is established between two stations using a paraboloid antenna. The distance between the two stations is 60 km and the operating frequency of FM radio is 98.6 MHz The power transmitter antenna is 20 W, and the gains of the transmitting and receiving antennas are 12 dB and 16 dB respectively. Then determine the following attributes. (i) Free space loss. (ii) Effective aperture of the transmitting antenna (iii) EIRP of the transmitting antenna. (iv) Power received at the receiving antenna.	**10+10**	**CO3**