Ex/ET/T/314/2018

BETCE 3rd Year, 1st Semester Examination 2018

Subject: Antennas & propagation

Time: Three hours **Full Marks: 100**

Q.1 is compulsory and answer any four (4) questions from Q.2 to Q.9

Q.1

a) Radiation resistance $U(\theta, \varphi) = \cos^4\theta \sin^2\varphi$ for $0 \leq \theta \leq \frac{\pi}{2} and\ 0 \leq \varphi \leq 2\pi$ and zero for lower half space. Find out Directivity.

b) For an antenna with overall length $l = 5\lambda$ and the observations are made at $r = 60\lambda$. Find the error in phase.

c) Find out the operating frequency of a short monopole antenna if the radiation resistance is 0.05Ω and monopole height is of 120mm.

d) A LOS link at 10GHz is to be established on the surface of earth (radius = 6370Km). The straight line distance between the antenna is 60Km and height of the transmitter is 60m. Calculate the minimum height of receiving antenna assuming propagation is taking place in absence of atmosphere.

e) Explain the operation of ionosonde.

f) A radio station has an EIRP of 25 kW and a transmit power of 1.73 kW. What is the gain of the antenna?

g) Calculate the first Fresnel zone obstruction height maximum for f = 800 MHz.

h) A ship-to-ship marine-band VHF radio operates at 156 MHz and is limited to a maximum of 25 watts. The signal propagates via space propagation, so it is limited in range to direct line-of-sight. A Coast Guard transmitting station on shore has a monopole antenna that is 350 feet tall. If a ship is 35 miles (56,315 m) away from the CG station, how high must the ship's monopole antenna be mounted to ensure reception?

i) Draw two different feeding arrangements of Log Periodic Dipole Array.

j) How many grating lobes are present in the visible region of array factor of uniform array having inter-element spacing of 3λ and a uniform progressive phase shift of $-\frac{\pi}{3}$ in excitation?

10 x 2 = 20

[Turn over

Q.2

a) Radiation efficiency of an antenna is 90%. Maximum radiation intensity is of 0.7W/Sr. Calculate the directivity of the antenna for Pin = 0.4W and Prad = 0.3W.

b) Proof that $\vec{J} = \nabla \times \vec{H}$ by using Stokes theorem.

c) Proof Lorentz Gauge condition.

4+10+6 =20

Q.3

a) Explain how a single wire can radiate. Describe all possible conditions with figures.

b) In a two wire transmission line how the field lines propagates in a closed loop with sinusoidal phase distribution? Explain the causes of electric field line bending at the rear ends of line by using the concept of charge and equi-potential surface.

c) Draw and explain current distribution for a dipole having length $\frac{\lambda}{2} < l < \frac{3\lambda}{4}$. What are the voltage nulls?

d) Proof that Perpendicular component of Electric Field in Larmore's theorem decays with increase in length (r) from observation point for a charge particle moving with acceleration.

4+6+4+6=20

Q.4

a) Radial component of radiated power density of an antenna is $X_{rad} = \widehat{a_r} X_r = \widehat{a} A_0 \sin\frac{\theta}{r^2}$ W/mt^2 . Find the total radiated power. Find also the maximum directivity of the antenna.

b) By using Legendre Polynomial (n element), describe individual voltage component related to monopole and dipole. From that, find out that dipole moment for two charges is **qxs**.

c) In a Hertzian Dipole, deduce the field components in the intermediate region. Also plot the phasor diagram of E_r, E_θ, H_φ at intermediate region.

4+6+10 =20

Q.5

a) Calculate E_θ, H_φ component for λ/2 dipole operating at 350MHz at a distance of 150mt, in the plane of maximum radiation. Also find out the total power radiated by this dipole if the input current is 150 (0^0) mA.

b) Find the array factor for an array of two isotropic source in which elements are separated by a distance of 3.75cm and the elements are excited with uniform current and in same phase at 2GHz. Plot the array factor also.

c) For an N element Broadside array, find out the direction of nulls. What is the value of First Null Beam Width?

d) For a Magnetic Dipole (loop), find out the Magnetic field **B** component. Also comments on the direction of **B** component with respect to the **B** component of Electric Dipole at far field.

5+5+6+4 =20

Q. 6

a) What is EIRP? Consider a 100m link that operates at 10GHz. Assume transmitted power is 1W. Both transmitter and receiver antenna have 5dB gain. If the receiver threshold is -8dBm, then what is available link margin?

b) A horizontal dipole antenna situated at a height 9m from ground is radiating EM wave at 900MHz. A polarization matched receiver antenna is kept at a height 1.5m above ground. Calculate the path loss if horizontal distance between antenna changes from 50m to 250m. Assume reflection coefficient of ground is -1.

c) Deduce the general complex reflection coefficient for perpendicular reflection.

d) How interaction of the two medium in wave propagation can be modeled by using circuit concept?

6+4+6+4=20

Q. 7

a) Explain the properties of D and E layer.

b) Deduce the expression of Plasma frequency having without earth's magnetic field. What is critical frequency?

c) Refractive index of an ionosphere is 0.9. and MUF is 9GHz. If the height of the layer is 400Km above earth's surface, then find out the maximum electron density, critical frequency. Assume flat earth surface.

d) A pulse of a given frequency is transmitted upward and is received back after a period of 2mses. Find the vertical height of reflecting layer.

4+6+6+4=20

Q.8

a) Explain optimum working frequency and lowest usable frequency.

b) Sky wave reflects from an ionosphere layer having altitude of 400Km and $\rho = 0.9$ at 10MHz. Find out the skip distance for which MUF is 10MHz.

c) A sky wave is incident on D layer at an angle of 30^0. If the frequency of transmitted signal is 50MHz (sinusoidal) and electron density is 500 e/cm^3, then find out the angle of refraction. Now if the 50MHz signal is of pulsed type, then explain the scheme by which identical types of operation as previous can be obtained.

d) Proof that f_{MUF} for short distance communication is $\boldsymbol{f_{MUF} = f_c\sqrt{1+\frac{D^2}{4h^2}}}$

6+4+6+4=20

Q.9

a) What is Fresnel's zone in knife edge diffraction? How Kornu spiral can be constructed in phasor diagram.

b) What is Earth Bulge? Explain the condition for sub-refraction and super-refraction. Why N= -39 is taken as standard atmospheric condition.

c) If the refractive index of air decreases with height and the gradient is of 0.065×10^{-6} m^{-1}. Find the equivalent radius of earth.

d) Explain the mechanism of Duct Propagation.

6+6+4+4=20