BETCE 3rd Year, 1st Semester Examination 2019

Subject: Antennas & propagation

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

Q.1 is compulsory and answer four (4) questions :: any two (2) questions from each sections :: (Antenna & Propagation)

Q.1

a) Radiation resistance $U(\theta, \varphi) = \cos^2\theta \sin^2\varphi$ 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) What is multipole expansion?

c) What is irotaional theorem?

d) Write the condition of Vector **H** in the far field of an antenna.

e) For an antenna with overall length $l = 3\lambda$ and the observations are made at $r = 60\lambda$. Find the error in phase.

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

g) For a Hertzian Dipole, what is the HPBW value in E plane?

h) 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.

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

j) The refractive index of an ionosphere layer is 0.92 and MUF is 10MHz. If the height of the ionosphere layer is 400 Km above earth's surface then find out the distance between transmitter and receiver assuming the earth's surface is flat

10 x 2 = 20

[Turn over

Section - 1 :: Antenna

any two (2) questions from Q.2 to Q.5

Q.2 A

a) Explain how radiation initiates in antenna structure?

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

c) Proof Lorentz Gauge condition.

6+8+6 =20

Or

Q2 B

a) Proof that the radiation starts from an antenna is an Electromagnetic Wave.

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

c) 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.

7+5+8 =20

Q.3 A

a) 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.

b) What is Magnetic vector potential? Explain how multipole components can be derived for a cluster of charge enclosed in a volume? From that general relationship, how to get dipole conditions

10+2+6+2=20

Or

Q.3 B

a) What is the difference between relativistic and non relativistic domain of motion? What will happen in the Larmor's field component in relativistic domain? What is length contraction phenomenon?

b) What is time dilation? Explain the operation of electric dipole radiation in view of time dilation. From that, proof that $\langle P \rangle = \frac{1}{4\pi\epsilon_0} \frac{p_0^2 \omega^4}{3c^3}$

3+5+3+2+7=20

Q.4 A

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) 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.

c) Proof Radiation resistance of Hertzian dipole is $R_r = 80\pi^2 \left[\frac{dl}{\lambda}\right]^2$.

4+10+6 =20

Or

Q.4 B

a) How the analogy between isolated current element and charge accumulation at the end of wire can be described?

b) What are the different zones of measurement in antenna? Explain the relations for radiating near field and far field.

c) Deduce the field Electric field component of a magnetic dipole.

5+7+8=20

Q.5 A

a) 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.

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

c) What will be the condition for AF for a series feed two element antenna array. Explain the basic difference in AF in between series and shunt feed.

5+10+5=20

Or

Q.5 B

a) Explain the operation of Yagi Uda antenna array. Why Folded dipole is used in Yagi Uda array.

b) How Log Periodic antenna is different from Yagi Uda antenna? Explain how the frequency independent operation is achieved in five element alternate feed Log periodic antenna array.

c) Plot the radiation pattern of an array in broadside which consist of four isotropic elements fed with equal magnitude of currents in same phase and the inter-element spacing is half wavelength.

4+3+3+4+6=20

Section - 2 :: Propagation

any two (2) questions from Q.6 to Q.8

Q. 6 A

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 -85dBm, 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.

2+6+6+6=20

Or

Q.6 B

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

b) What is atmospheric propagation? How surface wave propagation is happened ? what is Radio Horizon?

c) Explain How equivalent earth radius can be increased to 4/3 amount to cater the tangential radio horizon.

4+3+3+2+8=20

Q. 7 A

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

b) Explain the operation of ground wave in between transmitter and receiver antenna over flat earth. What is coverage diagram?

5+5+7+3=20

Or

Q. 7 B

a) 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.

b) A transmitter transmit 45Watt at 90MHz towards the receiver located 50Km away from it. The height of the transmitter antenna is 100m. What is the field intensity at receiver antenna?

c) Explain the parallel and perpendicular polarization with figure.

d) What are different non LOS propagation?

4+6+3+3+4=20

Q. 8 A

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.

3+3+6+4+4=20

Or

Q.8 B

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