KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2018

Marks Scored:

Level : B.E.
Year : IV

Course : ETEG 402
Semester: I

Exam Roll No:

Time: 30 mins.

F.M. : 10

Registration No.:

Date MAR 0 8 2018

SECTION "A"
[20 Q.×0.5=10 marks]

1) If the path difference between two waves arriving at a destination after traveling through different paths is λ/2, what would be the phase difference between them?
a) $\pi/2$ b) π c) 2π d) $\frac{2\pi}{\lambda}+\frac{\lambda}{2}$

2) Which of the following layer of ionosphere is present only in the day but disappears in the night ?
a) Sporadic E layer b) Normal E layer
c) D layer d) Sporadic F layer

3) Which of the following charge configurations is capable of radiation of e-m wave?
a) Stationary surface charge in a hollow curved conductor
b) Stationary surface charge in a hollow straight conductor
c) Charge moving with uniform velocity along a curved conductor
d) Charge moving with uniform velocity along a straight conductor

4) Front to back ratio compares the radiation of antennas towards .....
a) 0° and 180° b) 0° and 90° c) 90° and 180° d) 180° and 360°

5) A dipole of length 20 cm is fed with signal of wavelength 20 m. The radiation resistance of the dipole will be.....
a) 0.316 Ω b) 0.079 Ω c) 0.02 Ω d) 0.079 Ω

6) When a helical antenna is working in normal mode, its polarization will be circular only when its axial ratio is.....
a) less than one b) greater than one c) equal to one d) zero

7) A half wave dipole has the approximate impedance of 73 Ω. The folded half wave dipole will thus have the impedance approximately equal to.....
a) 300 Ω b) 150 Ω c) 200 Ω d) 50 Ω

8) A practical half wave dipole is .....in length.
a) 0.5λ b) 0.47λ to 0.48λ c) 0.52λ to 0.53λ d) 0.25λ

9) The directivity of an antenna is 2. It is gain of .....over half wave dipole.
a) 2.15 dB b) 1.64 dB c) 3.01 dB d) 0.86 dB

10) In a V antenna, if θ_m denote the direction of major lobe for each leg, and θ_0 denote the included angle of the V, the condition $\theta_0 = 2\theta_m$ causes.....
a) optimum directivity.
b) main lobe to be split to two distinct beams.
c) single main lobe but tilted upwards from plane of V.
d) single main lobe in the plane of V.

11) Yagi Uda antenna CANNOT be considered as an example of.....
a) travelling wave antenna
b) frequency independent antenna
c) antenna array with passive elements
d) end fire antenna array

12) Which of the following is NOT TRUE about a planar equiangular spiral antenna?
a) It is a bidirectional antenna
b) It has lobes normal to plane of spiral
c) It is linearly polarized antenna
d) It is frequency independent antenna

13) A parabolic reflector antenna with diameter 10 m is fed with signal of frequency 30 MHz. The directivity of the antenna will be.....
a) 9.87 b) 9.87 dB c) 20.2 dB d) 20.2

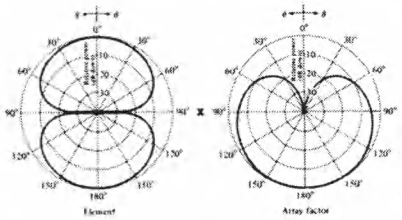
14) The characteristic impedance of the quarter wave transformer for impedance matching is.....
a) $Z_1 = R_{in}Z_0$ b) $Z_1 = {R_{in}}^2 Z_0$ c) $Z_1 = R_{in}{Z_0}^2$ d) $Z_1 = \sqrt{R_{in}Z_0}$

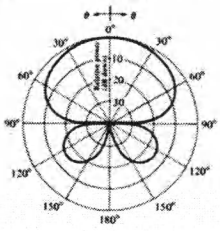
15) For a ionospheric layer the electron density is $10 \times 10^{12} electrons/m^3$. If the frequency of the wave is 100 MHz, the refractive index of the layer for the wave is.....
a) 0.958 b) 0.919 c) 1.958 d) None of the above

16) The largest frequency that will be returned to earth when transmitted vertically under given ionospheric conditions is called the .....
a) Maximum usable frequency (MUF)
b) Optimum working frequency (OWF)
c) Critical frequency
d) Skip frequency

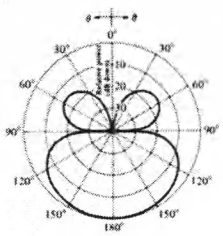
17) Which of the following is not a existing matching technique?
a) T match b) Pi match c) Omega Match d) Resonant T match

18) The element pattern and array factor of an array is as given. Which of the following is the resultant pattern obtained by pattern multiplication?





a)



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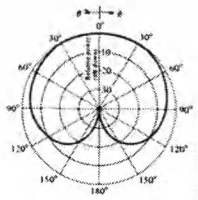

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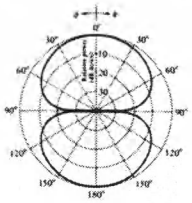

d)

19. Which of the following is not a practical antenna?

a) isotropic antenna
b) omnidirectional antenna
c) broadside antenna
d) directive antenna

20. Phase angle of the reflection factor for wave reflection from lossy medium like earth for horizontal polarization and incidence angle ψ equal to zero is:

a) 90°
b) -90°
c) 180°
d) -180°

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SECTION "B"
[5 Q.×8=40 marks]

Attempt any five questions. Candidates are instructed to be specific while writing answers. Assume suitable values for any missing parameters.

1. a. Explain the application of antenna in wireless communication. Why an antenna is sometimes also called a transducer? [2]

   b. An alternating current element (Hertzian dipole) has current $I = A_0 Cos\omega t$. The current element is aligned along z axis and is located at origin. The expressions for the electric and magnetic field intensities at any point P(r, θ, ϕ) are provided at the end. Obtain the expression for the total power transmitted by the radiator and also find the radiation resistance. [4]

   c. A half wave dipole is required to generate an electric field strength of 5 $\mu V/m$ at a receiver located 2 km far in the direction given by $\theta = \frac{\pi}{2}$, $\phi = 0$. Neglecting the ohmic loss and considering air as medium, find the total power required to be transmitted by the dipole. [2]

2. a. Explain the terms *'Beamwidth'*, *'Beam Efficiency'* and *'Bandwidth'* as related to the antenna. [3]

   b. A finite length dipole with loss resistance$R_L = 1\Omega$, radiation resistance $R_r = 73\Omega$ and reactance $X_A = 42.5$ is connected to a generator whose impedance is matched with the antenna. If the peak voltage of the generator is 2 V, find the power radiated by the dipole, power dissipated at the dipole, power dissipated at the generator and total power supplied by the generator. [3]

   c. What are different types of efficiency parameters defined for an antenna? What do you understand when it is said that *'the aperture efficiency of an antenna is 65%'*? [2]

3. a. Derive Friis Transmission equation. [4]
   Transmitting and receiving antennas operating at 1 GHz with gains of 20 and 15 dB respectively are separated by a distance of 1 Km. Find the maximum power delivered to the load when the input power is 150 W. Assume the antennas are polarization matched and lossless.

   b. Compute the radiation resistance of a dipole of length = $3\lambda/2$. Use the sine and cosine integral tables provided at the end and consider the medium to be free space. [2]

   c. How can bandwidth of dipoles be increased? Introduce some broadband dipole antennas you know. [2]

4. a. An antenna with its only maximum along $\phi = 0°$ is required to be designed. For this purpose, a two element uniform linear array of isotropic sources positioned along z-axis and separated by a distance of $\lambda/4$ is being used. Assuming ordinary endfire conditions to meet above requirement, find α, AF, and resulting directivity. [3]

b. Write short description of V antennas with focus on its radiation pattern and directivity. [2]

c. Design a five turn helical antenna which at 200 MHz operates in the normal mode. The spacing between turns is λ/20. It is desired that the antenna possesses circular polarization. Determine the circumference of the helix, length of the single turn, overall length of the helix, pitch angle. [3]

5. a. State the principle of frequency independence in antennas. Describe the construction and operation of log periodic dipole array (LPDA). [3]

b. A standard pyramidal horn operating at $f = 8.2$ GHz has dimensions of $\rho_1 = 13.46\,cm$, $\rho_2 = 15.75\,cm$, $a_1 = 7.85\,cm$, $b_1 = 5.94\,cm$, $a = 2.286\,cm$, $b = 1.016\,cm$. Compute approximate directivity (in dB). [3]

c. A satellite communication system has space station (satellite) at space and earth stations at earth surface. What do you think are some important factors that should be considered while choosing antennas at those stations? [2]

6. a. Classify ionospheric regions based on electron concentration. Also explain the mechanism of ionospheric propagation. [3]

b. When an e-m wave is reflected from a surface, its magnitude and phase changes. Derive the expression for the reflection factor for a horizontally polarized oblique incident wave when reflected from a lossy medium like earth. [3]

c. An ionospheric region at a particular height has a maximum electron density of $9 \times 10^{12} electrons/m^3$. What is the highest value of frequency that will be reflected back for the vertical incidence from that height? If the incidence angle is 45°, what is the highest frequency that will be reflected back? [2]

Note: Some useful relationships:

For alternating current elements:

$$\vec{H} = \frac{A_0\, dl\, Sin\theta}{4\pi}\left[-\frac{\omega\, Sin\omega t}{rv} + \frac{Cos\omega t'}{r^2}\right]\hat{a}_\phi \qquad E_r = \frac{2A_0\, dl\, Cos\theta}{4\pi\varepsilon}\left[\frac{Cos\omega t'}{r^2 v} + \frac{Sin\omega t'}{\omega r^3}\right]$$

$$E_\theta = \frac{A_0\, dl\, Sin\theta}{4\pi\varepsilon}\left(-\frac{\omega\, Sin\omega t'}{r v^2} - \frac{\left(-Cos\omega t'\right)}{r^2 v} + \frac{Sin\omega t'}{\omega r^3}\right) \qquad E_\phi = 0$$

For half wave dipoles,

$$E = j\frac{60\, I_m\, e^{-j\beta r}}{r}\frac{Cos\left(\pi/2\, Cos\theta\right)}{Sin\theta} \qquad P_{rad} = 1.218\frac{\eta I_m^{\,2}}{4\pi}$$

For a finite length dipole,

$$R_{rad} = \frac{\eta}{2\pi}\left[\begin{array}{l} C + \ln(2\beta H) - C_i(2\beta H) + \frac{1}{2}Sin(2\beta H)\{S_i(4\beta H) - 2S_i(2\beta H)\} \\ + \frac{1}{2}Cos(2\beta H)\{C + \ln(\beta H) + C_i(4\beta H) - 2C_i(2\beta H)\} \end{array}\right] \qquad C=0.5772$$

For helical antennas is normal mode,

$$AR = \frac{|E_\theta|}{|E_\phi|} = \frac{2\lambda S}{C^2}$$

For circular polarization, AR should be equal to 1.

$$L_0 = \sqrt{S^2 + (C)^2} \qquad \alpha = \tan^{-1}\frac{S}{C} = \tan^{-1}\frac{S}{\pi D}$$

For horn antennas:

$$A = \frac{a_1}{\lambda}\sqrt{\frac{50}{\rho h/\lambda}} \qquad D_H = \frac{b}{\lambda}\frac{Gh}{\sqrt{\frac{50}{\rho h/\lambda}}} \qquad B = \frac{b_1}{\lambda}\sqrt{\frac{50}{\rho e/\lambda}} \qquad G_h = \frac{32}{\lambda}A \qquad G_e = \frac{32}{\lambda}B \qquad D_E = \frac{a}{\lambda}\frac{G_e}{\sqrt{\frac{50}{\rho e/\lambda}}}$$

$$D = \frac{\lambda^2\pi}{32\,a\,b}D_E D_H$$

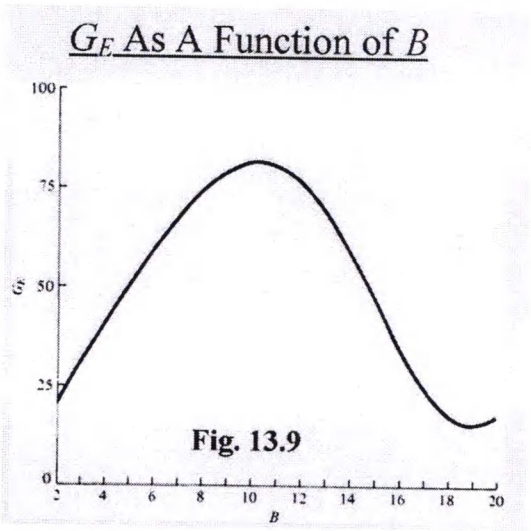

Fig. 13.9

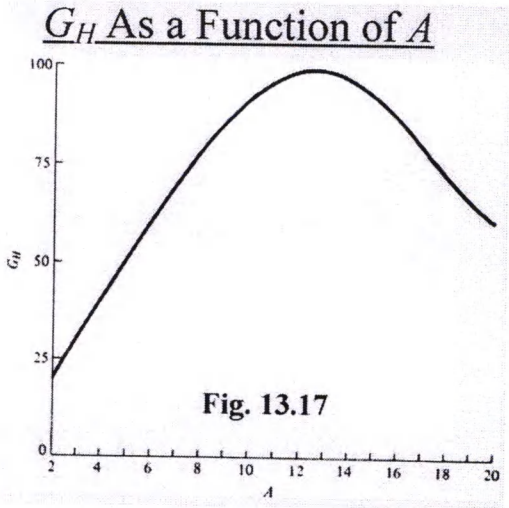

Fig. 13.17

Sine and Cosine integral tables:

x	$S_i(x)$	$C_i(x)$
8.9	1.65993	0.00528
9.0	1.66504	0.05535
9.1	1.66908	0.04507
9.2	1.67205	0.03455
9.3	1.67393	0.02391
9.4	1.67473	0.01325
9.5	1.67446	0.00268
9.6	1.67316	−0.00771
9.7	1.67084	−0.01780
9.8	1.66757	−0.02752
9.9	1.66338	−0.03676
10.0	1.65835	−0.04546
10.1	1.65253	−0.05352

x	$S_i(x)$	$C_i(x)$
18.0	1.53661	−0.04348
18.1	1.53264	−0.03962
18.2	1.52909	−0.03540
18.3	1.52600	−0.03088
18.4	1.52339	−0.02610
18.5	1.52128	−0.02111
18.6	1.51969	−0.01596
18.7	1.51863	−0.01071
18.8	1.51810	−0.00540
18.9	1.51810	−0.00010
19.0	1.51863	0.00515
19.1	1.51967	0.01029
19.2	1.52122	0.01528
19.3	1.52324	0.02006
19.4	1.52572	0.02459
19.5	1.52863	0.02883