Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2019

Level : B. E.
Year : IV

Course : ETEG 402
Semester: I

Exam Roll No. : Time: 30 mins. F. M. : 10

Registration No.: Date : FEB 25 2019

SECTION "A"
[20 Q × 0.5 = 10 marks]

1) The range of SHF in common radio frequency band designation is.......
a) $3 - 30\ GHz$ b) $300 - 3000\ MHz$
c) $30 - 300\ MHz$ d) $30 - 300\ GHz$

2) Which of the following layer of ionosphere splits to two layers in day time while merges to a single layer at night?
a) E layer b) F layer c) D layer d) C layer

3) In the radiation pattern of a multilobe directive antenna, the lobe that is at 180° to the major beam is called...........
a) side lobe b) principle lobe c) minor lobe d) back lobe

4) Which of the following parameter is also called 3-dB beamwidth?
a) FNBW b) HPBW c) beamsolid angle d) all of above

5) When an antenna radiates EM wave, the parameter that is independent of distance is......
a) electric field intensity b) magnetic field intensity
c) radiation intensity d) power density

6) Which of the following is usually the most important parameter for a transmitting antenna?
a) low side lobes b) large signal to noise ratio
c) high gain and efficiency d) large bandwidth

7) Maximum effective aperture of an isotropic antenna operating at 1 GHz is.....
a) 7 b) 0.7 c) 0.07 d) 0.007

8) A uniform linear array with uniform phase shift of 90° between its elements separated at distances of $\frac{\lambda}{2}$ has its principal maximum towards.......
a) 60° b) 30° c) 90° d) 45°

9) A uniform linear array with its elements separated at distances of $\frac{\lambda}{2}$ will be an end fire array if the phase shift between its elements is.........
a) 90° b) 180° c) 270° d) 0°

10) In free space propagation, if the link is between two fixed gain antennas, the received power is....
a) independent of frequency.
b) directly proportional to square of frequency.
c) inversely proportional to square of frequency.
d) inversely proportional to frequency.

11) Which of the following is NOT the example of frequency independent antenna design?
a) Helical antennas
b) LPDA
c) Planar spiral antenna
d) Log periodic tooth antenna

12) Radiation resistance of a infinitesimal dipole of length $\frac{\lambda}{50}$ is ....
a) 73 Ω
b) 36.5 Ω
c) 3.16 Ω
d) 0.316 Ω

13) Which of the following matching technique inherently does not include a capacitor?
a) Gamma match
b) Omega match
c) T match
d) resonant T match

14) In a circular loop antenna, doubling the number of loops.............
a) increases the radiation resistance
b) increases the directivity
c) causes multiple lobes to appear
d) increases the bandwidth

15) For a long wire beverage antenna, as the length increases, which of the following is not its consequence?
a) number of lobes increase
b) major lobe shifts closer towards axis
c) directivity decreases
d) amplitude of minor lobes decreases

16) If we arrange antennas based on ascending order of typical gain, which of the following order is correct?
a) dipoles, horn, yagi, parabolic reflector
b) dipoles, yagi, horn, parabolic reflector
c) yagi, dipoles, parabolic reflector, horn
d) dipoles, parabolic reflector, yagi, horn

17) For a vertically polarized wave striking the earth surface at an angle nearly parallel with earth surface, the reflected wave will be......
a) same to incident wave in magnitude and phase
b) same in phase but magnitude will be severely reduced than that of incident wave
c) magnitude will be very small and phase will be changed by180°
d) magnitude will remain same and phase will be changed by180°

18) For the ionospheric propagation from a layer, critical frequency is 20 MHz. If the angle of incidence is 30°, the maximum usable frequency is:
a) 23 MHz
b) 20 MHz
c) 17 MHz
d) 25 MHz

19) The most common antenna used in satellite ground stations is......
a) horn antennas
b) dipole antennas
c) parabolic reflector antennas
d) helical antennas

20) The value of directivity of an antenna is always......
a) Less than 1
b) greater than 1
c) between 0 to 1
d) between -1 to 1

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SECTION "B"
[5Q × 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. A half wave dipole with sinusoidal current located at origin and aligned along z axis radiates the EM wave to create EM field at some point $P(r,\theta,\phi)$. Derive the expressions for the electric and magnetic field intensities at the point. [4]
Consider that the retarded vector potential due to a current element is:

$$dA = \frac{\mu}{4\pi}\frac{I_0\, dl\, Cos\omega\left(t - \frac{R}{v}\right)}{R}$$

which in phasor form is: $$dA = \frac{\mu}{4\pi}\frac{I_0\, dl\, e^{-j\beta R}}{R}$$

b. Fields around an antenna are usually divided into reactive near field, Fresnel (radiating near field) and Fraunhofer (far field) regions. Explain about those regions. [2]

c. Explain the communicational and non communicational application areas of antenna. [2]

2. a. What do you understand by radiation pattern of an antenna? Explain with suitable expressions and figures. [3]

b. Compute the radiation intensity, directive gain and directivity of an infinitesimal dipole. [3]

c. An antenna radiating total power of 20 kW has directive gain $g_d = 5\ dB$ towards a certain direction in space. Find the magnitude of electric field intensity at a distance of 10 km from the antenna in the same direction. [2]

3. a. State and prove reciprocity theorem for antennas. [3]

b. A half wave dipole is operating as a receiver for transmitted signal at a frequency of 15 MHz. What will be the maximum effective area of the dipole? If the total power received by the dipole is 100 nW, what is the power density of the incident wave at the antenna location? [2]

c. The aerial distance between the transmitting antenna at Nepal Telecom Biratnagar exchange and Birgunj exchange is 250 km. The communication link between these two is through a microwave link at frequency of 1 GHz using parabolic reflector antennas. The gains of the transmitter and receiver antennas are respectively 25 and 18 dB respectively. If a minimum of 5 mW power is to be received at the receiver, estimate the total power to be transmitted considering the free space transmission. Also compute the free space path loss. [3]

4. a. For a 10 element uniform linear broadside array of isotropic elements with separation of $\lambda/4$ between the elements, find the HPBW, FNBW and directivity of the array. [2]

b. Thin wire dipole antennas have very useful radiation patterns for terrestrial broadcasting purpose. However, they are narrowband in terms of bandwidth. Discuss the principle of increasing the bandwidth of the dipoles and some broad band dipole antennas. [3]

c. What is the need of impedance matching in antennas? Explain the operation of Gamma match used in matching of dipoles.. [3]

5. a. Compute the radiation resistance of an thin wire dipole of length $l = \lambda$. [2]

b. Explain the construction and operation of Yagi-Uda antenna along with its radiation patterns. [3]

c. Derive the expression for the reflection factor for a vertically polarized oblique incident wave when reflected from a surface of earth. [3]

6. a. Show that the refractive index of any layer in ionosphere is given by $n = \sqrt{1 - \frac{81N}{f^2}}$. Where the symbols have usual meanings. [3]

b. How do frequency independence different from the concept of wide bandwidth? Explain construction and operation of planar spiral antennas. [3]

c. Introduce different feed techniques used in parabolic reflector antennas. [2]

Note: Some useful relationships:

Definition of curl for spherical coordinate system:

$$\nabla \times \mathbf{H} = \frac{1}{r\sin\theta}\left(\frac{\partial(H_\phi \sin\theta)}{\partial\theta} - \frac{\partial H_\theta}{\partial\phi}\right)\mathbf{a}_r + \frac{1}{r}\left(\frac{1}{\sin\theta}\frac{\partial H_r}{\partial\phi} - \frac{\partial(rH_\phi)}{\partial r}\right)\mathbf{a}_\theta + \frac{1}{r}\left(\frac{\partial(rH_\theta)}{\partial r} - \frac{\partial H_r}{\partial\theta}\right)\mathbf{a}_\phi \quad \text{(spherical)}$$

For dipoles,

$$A_e = \left(\frac{\lambda^2}{4\pi}\right)D \qquad\qquad P_{rad} = 1.218\frac{\eta I_m^{\;2}}{4\pi}$$

For a finite length dipole,

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

C=0.5772

Sine and Cosine integral tables:

x	$S_i(x)$	$C_i(x)$
2.3	[illegible]	[illegible]
2.4	1.75249	0.31729
2.5	1.77852	0.28587
2.6	1.80039	0.25334
2.7	1.81821	0.22008
2.8	1.83210	0.18649
2.9	1.84219	0.15290
3.0	1.84865	0.11963
3.1	1.85166	0.08699
3.2	1.85140	0.05526
3.3	1.84808	0.02468
3.4	1.84191	−0.00452
3.5	1.83313	−0.03213
3.6	1.82195	−0.05797

x	$S_i(x)$	$C_i(x)$
5.1	1.53125	−0.18348
5.2	1.51367	−0.17525
5.3	1.49732	−0.16551
5.4	1.48230	−0.15439
5.5	1.46872	−0.14205
5.6	1.45667	−0.12867
5.7	1.44620	−0.11441
5.8	1.43736	−0.09944
5.9	1.43018	−0.08393
6.0	1.42469	−0.06806
6.1	1.42087	−0.05198
6.2	1.41871	−0.03587
6.3	1.41817	−0.01989
6.4	1.41922	−0.00418
6.5	[illegible]	[illegible]

x	$S_i(x)$	$C_i(x)$
11.8	1.51535	−0.06297
11.9	1.50981	−0.05661
12.0	1.50497	−0.04978
12.1	1.50088	−0.04257
12.2	1.49755	−0.03504
12.3	1.49501	−0.02729
12.4	1.49327	−0.01938
12.5	1.49234	−0.01141
12.6	1.49221	−0.00344
12.7	1.49287	0.00443
12.8	1.49430	0.01214
12.9	1.49647	0.01961
13.0	1.49936	0.02676
13.1	1.50292	0.03355
13.2	1.50711	0.03989
13.3	1.51188	0.04574
13.4	1.51716	0.05104
13.5	1.52291	0.05576