Marks Scored:

KATHMANDU UNIVERSITY
End Semester Examination [C]
April, 2023

Level : B.E.
Year : IV

Course : ETEG 402
Semester : I

Exam Roll No. :

Time: 30 mins.

F. M. : 10

09 APR 2023

Registration No.:

Date :

SECTION "A"
[20Q. × 0.5 = 10 marks]

Encircle the most appropriate option.

1. An antenna is not _____.
   a. a transducer
   b. usually a metallic device
   c. an important component of communication system
   d. an lossless device

2. If **A** is vector magnetic potential, which of following expression defines **A**?
   a. $\nabla \times \boldsymbol{A} = \boldsymbol{B}$ b. $\nabla . \boldsymbol{A} = \boldsymbol{B}$ c. $\nabla \times \boldsymbol{B} = \boldsymbol{A}$ d. $\nabla . \boldsymbol{B} = \boldsymbol{A}$

3. Radiation resistance of a half wave dipole is _____.
   a. 36.56 Ω b. 73.12 Ω c. 19.28 Ω d. 100 Ω

4. A linear wire antenna of physical length 10 m is operating at 15 MHz. It can be called as
   a. Hertzian dipole b. Short dipole
   c. Halfwave dipole d. Quarter wave monopole

5. Which of the following option is **FALSE**?
   a. Omni-directional antenna is a special case of directional antenna
   b. End-fire array antenna has its main beam normal to the axis containing antenna
   c. Directional antenna radiates power effectively in particular directions compared to other directions
   d. Isotropic antenna radiates power in all directions

6. What is the wavelength of Super high frequency (SHF) especially used in Radar & satellite communication?
   a. 1m – 10 m b. 1 cm – 10 cm c. 10 cm – 1 m d. 0.1 cm – 1 cm

7. A practical half wave dipole is usually slightly less than half wavelength long, in order to _____.
   a. increase its directivity b. increase its radiation resistance
   c. make its impedance real d. reduce number of side lobes

8. Power density at point in space due to an antenna is defined as _____ power per unit area.
   a. radiated b. reflected c. diffracted d. collected

9. For frequencies less than resonant frequency (where impedance is real), the impedance of the antenna is _____.
   a. inductive b. resistive
   c. either inductive or resistive d. capacitive

10. Yagi Uda antenna is an example of _____.
    a. aperture antenna
    b. phased scanning array
    c. antenna array with passive elements
    d. broad side antenna array

11. A helical antenna can work in _____.
    a. normal mode only
    b. axial mode
    c. normal mode or axial mode based on orientation
    d. normal mode or axial mode based on its size

12. A spiral antenna is a _____.
    a. frequency independent antenna
    b. reflector antenna
    c. array antenna
    d. isotropic antenna

13. Which of the following layer of ionosphere is present only in the day but disappears in the night?
    a. C layer
    b. D layer
    c. E layer
    d. F layer

14. Which is **NOT** a parameter used in ionospheric communication?
    a. critical frequency
    b. resonant frequency
    c. maximum usable frequency
    d. virtual height

15. Stub matching is the technique to match _____.
    a. frequency of generator with the antenna
    b. polarization of transmitter and receiver antenna
    c. impedance of transmission line with antenna
    d. impedances of transmitter and receiver antenna

16. Poynting vector provides _____.
    a. radiation intensity towards any direction
    b. total power radiated by an antenna
    c. current density at any point
    d. power density at any point in space

17. E plane and H plane horn antennas are types of _____ horn antenna.
    a. corrugated
    b. exponential
    c. sectoral
    d. conical

18. Which of the following is a dual reflector system?
    a. Parabolic reflector antenna
    b. Offset feed antenna
    c. Axial feed reflector antenna
    d. Cassegrain feed reflector antenna

19. Two linear wire antennas are polarization matched. Now, if one of them is rotated by 30°, the loss factor due to polarization mismatch is _____.
    a. 0.75
    b. 0.5
    c. 0
    d. 1

20. Travelling wave antennas are characterized by their _____.
    a. bidirectional radiation pattern
    b. unidirectional radiation pattern
    c. omnidirectional radiation pattern
    d. high bandwidth

KATHMANDU UNIVERSITY
End Semester Examination [C]
April, 2023

09 APR 2023

Level : B.E.
Year : IV
Time : 2 hrs. 30 mins.

Course : ETEG 402
Semester : I
F.M. : 40

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. What do you understand by radiation pattern of an antenna? Explain the radiation pattern of a typical directive antenna with suitable diagram. [4]

   b. Starting from the known expressions for the electric and magnetic field intensities, derive the expression for the power radiated by the current element and calculate the radiation resistance. [4]

2. a. Define following terms: [3]
   i. Antenna Polarization
   ii. Antenna Efficiency

   b. A hypothetical isotropic antenna is radiating in free space. At a distance of 100 m from the antenna, the total electric field (E_θ) is measured to be 5 V/m. Find the power density and power radiated [3]

   c. When a metallic structure does radiate? Explain. [2]

3. a. Microwave link is assumed to be free space condition. The antenna gains are each 40 dB, the frequency is l0 GHz and the path length is 90 km. Calculate the transmission path loss and received power for transmitted power of 10 Kw. [3]

   b. What are the parasitic components used in Yagi Uda array called? Explain their construction and significance. [2]

   c. Derive an expression for the total field of an array of two isotropic point sources with equal amplitude and opposite phase. [3]

4. a. What are the main differences between standing wave antenna and travelling wave antenna? Explain with neat sketch the construction, working principal and characteristic of V antenna. [3]

   b. The free-space impedance at the center point of the driven element of a 15-MHz Yagi-Uda array is 25 – j 25. Assuming the diameters of the wires of a T-match are $1.9\times10^{-3}\lambda$ (3.8 cm) and $6.35\times10^{-4}\lambda$ (1.27 cm), the center-to center spacing between the wires is $7.62\times10^{-3}\lambda$(15.24 cm), and the length l/2 of each T-match rod is 0.0285λ (57 cm), find the input impedance of the T-match [3]

   c. What are different types of horn antenna based on its construction? [2]

5. a. Explain the construction, operating modes and applications of helical antennas. [3]

b. A small parabolic reflector TV antenna for direct broadcast has the diameter of the reflector equal to 1 meter, determine at 3 GHz the directivity (in dB) of the antenna if the feed is such that [3]
   i. the illumination over the aperture is uniform (ideal)
   ii. the taper efficiency is 80% while the spillover efficiency is 85%. Assume no other losses. What is the total aperture efficiency of the antenna (in dB)?

c. Explain planar spiral antenna. [2]

6. a. Explain the layers of ionosphere and their importance for communication. [3]

b. What are Maximum Usable Frequency (MUF) and Critical Frequency? Derive the expression s for MUF and F_{cr}. [3]

c. The E layer of ionosphere has electron density up to $2 \times 10^{11}/m3$. Find the critical frequency and MUF is incidence angle is 60°. [2]

Some useful expressions:

For parabolic reflector antennas:

$$D = \left(\frac{\pi d}{\lambda}\right)^2 \epsilon_{ap}$$

For current element:

$$H_\phi = \frac{I_0\, dl\, Sin\theta}{4\pi}\left[-\frac{\omega Sin\omega t'}{rv} + \frac{Cos\omega t'}{r^2}\right]$$

$$E_r = \frac{2I_0\, dl\, Cos\theta}{4\pi\varepsilon}\left[\frac{Cos\omega t'}{r^2 v} + \frac{Sin\omega t'}{\omega r^3}\right] \qquad E_\theta = \frac{I_0\, dl\, Sin\theta}{4\pi\varepsilon}\left(-\frac{\omega Sin\omega t'}{r v^2} - \frac{\left(-Cos\omega t'\right)}{r^2 v} + \frac{Sin\omega}{\omega r^3}\right)$$

For T match:

$$\alpha = \frac{\ln(v)}{\ln(v) - \ln(u)} \text{ where, } u = {}^{a}/_{a'} \text{ and } v = {}^{s}/_{a'}$$

$$Z_t = jZ_0 \tan\left(\beta {}^{l'}/_{2}\right), \text{ where, } Z_0 \approx 276\log_{10}\left({}^{s}/_{\sqrt{aa'}}\right)$$

$$Z_{in} = \frac{2Z_t\left[(1+\alpha)^2 Z_a\right]}{2Z_t + (1+\alpha)^2 Z_a}$$

$$Y_{in} = \frac{1}{(1+\alpha)^2 Z_a} + \frac{1}{2Z_t} = \frac{Y_a}{(1+\alpha)^2} + \frac{1}{2Z_t}$$