Total No. of printed pages = 4

ECE 181801

Roll No. of candidate ☐☐☐☐☐☐☐☐☐

2022

B.Tech. 8th Semester End-Term Examination

ECE + ETE

ANTENNA AND WAVE PROPAGATION

(New Regulations (w.e.f. 2017 – 2018)) &

(New Syllabus (w.e.f. 2018 – 2019))

Full Marks – 70   Time – Three hours

The figures in the margin indicate full marks
for the questions.

Answer question No. 1 and any *four* from the rest.

1.   Choose the correct answer from the following :   (10 × 1 = 10)

   (i)   The directivity of an antenna array can be increased by adding more antenna elements, as a larger number of elements

       (a)   Improves the radiation efficiency

       (b)   Increases the effective area of the antenna

       (c)   Results in a better impedance matching

       (d)   Allow more power to be transmitted by the antenna

   (ii) The beam area for directivity to be 1 steradian is

       (a) 4π (b) $1/2\pi$

       (c) 2π (d) $1/4\pi$

   (iii) The radiation pattern of a half wave dipole has the shape of a

       (a)   Doughnut   (b)   Sphere

       (c)   Hemisphere   (d)   Circular

[Turn over

(iv) For a hertz dipole antenna, the Half Power Beam Width (HPBW) in the E-plane is

(a) 360°

(b) 180°

(c) 90°

(d) 45°

(v) The electric field of an electromagnetic wave propagating in the positive Z-direction is given by

$$E = \hat{a}_x \sin(\omega t - \beta z) + \hat{a}_y \sin\left(\omega t - \beta z + \frac{\pi}{2}\right)$$

The wave is

(a) Linearly polarized in the Z-direction

(b) Elliptically polarized

(c) Left hand circularly polarized

(d) Right hand circularly polarized

(vi) If the progressive shift in antenna array is equal to zero then it is called

(a) Broadside

(b) End-fire

(c) Yagi-Uda

(d) Fishbone antenna

(vii) Which antennas are renowned as patch antennas especially adopted for space craft applications?

(a) Aperture

(b) Microstrip

(c) Array

(d) Lens

(viii) What happens when the radiation resistance of the antenna matches the characteristic impedance of the transmission line?

(a) No transmission occurs

(b) No reception occurs

(c) SWR is maximum

(d) SWR is minimum

(ix) During ground wave propagation earth behaves like a

   (a) Leaky capacitor

   (b) Leaky inductor

   (c) Series combination of capacitor and inductor

   (d) Parallel combination of capacitor and inductor

(x) Space wave propagation reflects the waves with frequencies

   (a) Below 2 GHz   (b) 2 to 30 MHz

   (c) Above 30 GHz   (d) Above 30 MHz

2. (a) State Maxwell's equations and explain their physical significance.   (5)

   (b) Deduce the wave equation in a time varying field for a lossless medium.   (6)

   (c) What is Poynting's vector and what does it signify?   (4)

3. (a) What is radiation resistance? A thin dipole antenna is $\dfrac{\lambda}{15}$ long. If its loss resistance is $1.5\,\Omega$. Find the radiation resistance and the efficiency.

                                                                              (2+3=5)

   (b) Define the term "Directivity". Derive the relationship between effective area and gain of an antenna.   (2+8=10)

4. (a) Prove that the reciprocity theorem is applied to antennas and hence show the equality of directional patterns for transmission and reception by the same antenna.   (8)

   (b) Define broadside and End-fire arrays. What are the conditions for a linear array of N isotropic elements to radiate in end fire and broadside mode?   (2+5=7)

5. (a) What is folded dipole antenna? Briefly explain the operation of Yagi-uda antenna.   (2+5=7)

   (b) Design a linear array with spacing between the element of $d = \dfrac{\lambda}{2}$ such that it has zeros at $\theta = 0°$ and $\theta = 90°$. Determine the number of elements, their excitation coefficients, array factor and the radiation pattern. Use Schelkunoff's method.   (8)

6. (a) With reference to sky waves, define the following terms : $(4 \times 2 = 8)$

    (i) Virtual Height

    (ii) Critical Frequency

    (iii) MUF

    (iv) Skip distance

  (b) What is fading? What factors contribute to sky wave signal fading? $(1+2=3)$

  (c) Two points on earth are 1500 km apart and are to communicate by means of HF. For a single hop transmission, the critical frequency at that time is 7 MHz and conditions are idealized. Calculate the MUF for those two points if the height of the ionospheric layer is 300 km. (4)

7. (a) State and explain Babinet's principle. (5)

  (b) Write short notes on any *two* : $(2 \times 5 = 10)$

    (i) Log-periodic antenna

    (ii) Microstrip antenna

    (iii) Smart antenna

    (iv) Horn antenna

    (v) Helical antenna

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