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ECE 181603

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Roll No. of candidate

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2022

APR 07/2022
UNIT 3 OF 5
Azara, Haldimohapa,
Guwahati - 781017

B.Tech. 6th Semester End-Term Examination

ELECTROMAGNETIC WAVES

(New Regulation and New Syllabus)

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. Answer the following MCQs :

(10 × 1 = 10)

(i) Coulomb's law obeys the superposition principle if the media is not affected by the

- (a) location of the charges (b) position vectors
(c) permittivities (d) all of the above

(ii) A vector field is said to be solenoidal if

- (a) $\nabla A = 0$ (b) $\nabla \cdot A = 0$
(c) $\nabla \times (\nabla \cdot A) = 0$ (d) $\nabla (\nabla \times A) = 0$

(iii) A vector field is said to be irrotational or conservative if

- (a) $\nabla \times A = 0$ (b) $A = 0$
(c) $\nabla \cdot A = \text{non zero}$ (d) all of the above

(iv) Which of the following parameters is not a primary parameter?

- (a) Resistance (b) Attenuation constant
(c) Capacitance (d) Conductance

[Turn over

- (v) The characteristic impedance of a transmission line with impedance and admittance of 16 and 9 respectively is
- (a) 1.33 (b) 25
(c) 7 (d) 0.75
- (vi) The wavelength of a line with a phase constant of 6.28 units is
- (a) 2 (b) 1
(c) 0.5 (d) 6
- (vii) Standing wave ratio is defined as the
- (a) Ratio of voltage maxima to voltage minima
(b) Ratio of current minima to current maxima
(c) Product of voltage maxima and voltage minima
(d) Product of current maxima and current minima
- (viii) The dominant mode in wave guide is the mode which has
- (a) Highest frequency (b) Highest wavelength
(c) Lowest phase constant (d) Highest attenuation
- (ix) The dominant mode in rectangular waveguide is
- (a) TE_{01} (b) TE_{10}
(c) TM_{01} (d) TM_{10}
- (x) In a non-dispersive media, the phase velocity and the group velocity are equal to
- (a) c^2 (b) $c/2$
(c) $2c$ (d) c

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2. (a) Define gradient, divergence and curl. (3)
(b) Determine the curl of the following vector field – (4)
 $A = \rho z \sin \phi a_\rho + 3\rho z^2 \cos \phi a_\phi$
(c) State the stokes theorem and proof it. (8)
3. (a) Define Gauss's law. Using the Gauss's law, find the electric field at a distance 'r' of a sphere due to a point charge 'Q' at the origin. (5)
(b) If $G(r) = 10e^{-2r}(\rho a_\rho + a_z)$, determine the flux of G out of the entire surface of $\rho = 1$, $0 \leq Z \leq 1$. Confirm the result by using the divergence theorem. (10)

4. (a) Derive the Maxwell's modified Ampere's law. (5)
- (b) Write Maxwell's integral form of four equations in time varying field. (4)
- (c) Show that tangential component of the electric field is continuous and tangential component of magnetic field is discontinuous at the interface of two media. (6)
5. (a) Derive the transmission line equations in time domain and phasor domain. (7)
- (b) A distortionless line has $Z_0 = 60 \Omega$, $\alpha = 20 \text{ mNp/m}$, $v = 0.6c$, where c is the velocity of light in a vacuum. Find R , L , G , C and λ at 100 MHz . (8)
6. (a) State the pointing theorem and derive it. (7)
- (b) If $\epsilon_r = 1$ and $\mu_r = 1$ for the medium in which a wave with frequency $f = 0.3 \text{ GHz}$ is propagating. Determine the propagation constant and the intrinsic impedance of the medium when (4 + 4 = 8)
- (i) $\sigma = 0$
- (ii) $\sigma = 10 \text{ mho/m}$
7. (a) Find the expressions for the electric and the magnetic fields for a plane wave in arbitrary direction. (10)
- (b) Determine the cut-off frequencies for TE_{10} and TE_{01} modes in an air filled rectangular waveguide when $a/b = 2$ with $a = 4 \text{ cm}$. (5)

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