

Code : 100308

(2)

B.Tech 3rd Semester Exam., 2021
(New Course)

ELECTROMAGNETIC FIELD THEORY

Time : 3 hours

Full Marks : 70

Instructions

- (i) The marks are indicated in the right-hand margin.
- (ii) There are **NINE** questions in this paper.
- (iii) Attempt **FIVE** questions in all.
- (iv) Question No 1 is compulsory.
- (v) Symbols and notations carry their usual meanings.

1. Choose the correct answer of the following
(any seven) 2×7=14

- (a) The mathematical perception of the gradient is said to be
- (i) tangent
 - (ii) chord
 - (iii) slope
 - (iv) arc

- (b) The permeability of a dielectric material in air medium will be
- (i) absolute permeability
 - (ii) relative permeability
 - (iii) product of absolute and relative permeability
 - (iv) unity

- (c) The frequency in rad/sec of a wave with velocity of that of light and phase constant of 20 units (in GHz) is
- (i) 6
 - (ii) 60
 - (iii) 600
 - (iv) 0.6

- (d) One end of a lossless transmission line having the characteristic impedance of 75 ohm and length of 1 cm is short circuited. At 3 GHz, the input impedance at the other end of the transmission line is
- (i) 0
 - (ii) resistive
 - (iii) capacitive
 - (iv) inductive

- (e) A transmission line is distortionless, if
- $RL = 1/GC$
 - $RL = GC$
 - $LG = RC$
 - $RG = LC$
 - capacitive
- (f) In the design of a single-mode step-index optical fiber close to upper cutoff, the single-mode operation is NOT preserved, if
- radius as well as operating wavelength are halved
 - radius as well as operating wavelength are doubled
 - radius is halved and operating wavelength is doubled
 - radius is doubled and operating wavelength is halved
- (g) Which parameters cannot be computed from the Smith chart?
- Impedance
 - Admittance
 - Reflection coefficient and VSWR
 - Intrinsic impedance

- (h) In a microwave test bench, why is the microwave signal amplitude modulated at 1 kHz?
- To increase the sensitivity of measurement
 - To transmit the signal to a far-off place
 - To study amplitude modulation
 - Because crystal detector fails at microwave frequencies
- (i) The number of modes in a waveguide having a V number of 10 is
- 10
 - 25
 - 100
 - 50
- (j) The magnetization is defined by the ratio of
- magnetic moment to area
 - magnetic moment to volume
 - magnetic flux density to area
 - magnetic flux density to volume
2. Attempt any two parts of the following : $7 \times 2 = 14$
- (a) (i) What do you mean by transverse nature of EM wave? Explain mathematically.
- (ii) What are degenerative and dominant modes?

- (b) Write Maxwell's equations in free space for time varying fields both in differential and integral forms
- (c) The energy density of an electromagnetic wave is proportional to the square of the amplitude of the electric (or magnetic) field. Prove it.
3. Attempt any two parts of the following : $7 \times 2 = 14$

(a) Describe Poynting vector and Poynting theorem. What are their applications?

(b) Assuming that $B = \mu H$, show that Maxwell's equations imply the following complex valued version of Poynting's theorem :

$$\nabla \cdot (E \times H^*) = -j\omega\mu H \cdot H^* - E \cdot J_{tot}^*$$

where $J_{tot}^* = J + j\omega D$.

(c) Describe Kramers-Kronig dispersion relations.

4. Attempt any two parts of the following : $7 \times 2 = 14$

(a) (i) With the help of diagram, explain spherical coordinate system.

(ii) Write boundary condition for electric and magnetic fields.

8. Attempt any two parts of the following : $7 \times 2 = 14$

(a) Derive the expressions for magnetic field intensity due to toroidal coil and circular coil.

(b) Derive the expressions for energy stored and energy density in magnetic field.

(c) (i) Derive the expressions for self-inductance of two-wire transmission line.

(ii) Derive the expressions for force between two current-carrying conductors.

9. Attempt any two parts of the following :

$7 \times 2 = 14$

(a) (i) Define and explain Biot-Savart law.
(ii) Find H at the centre of an equivalent triangular loop of side 4 m carrying current of 5A.

(b) Define uniform plane wave propagation. Discuss and derive its properties.

(c) Write short notes on the following :

(i) Magnetic vector potential

(ii) Helmholtz equations

- (b) A transmission is lossless and 25 m long. It is terminated with a load of $Z_L = 40 + j30 \omega$ at a frequency of 10 MHz. The inductance and capacitance of the line are $L = 300\text{nH/m}$ and $c = 40\text{pF/m}$. Find input impedance at the source and at the midpoint of the line.
- (c) What is relation between conduction current density J_c and displacement current density J_d ?

5. Attempt any two parts of the following : $7 \times 2 = 14$

- (a) Compare circuit theory and field theory in detail.
- (b) Discuss reflection of plane wave at the interface of conductor for oblique interface.
- (c) Develop an expression for the potential difference at any point between spherical shells in terms of the applied potential employing Laplace's equation.

6. Attempt any two parts of the following : $7 \times 2 = 14$

- (a) (i) Write about reflection by a perfect dielectric at normal incidence.
- (ii) Write about conductors and dielectrics in detail.