Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

FOURTH SEMESTER BTECH. (E & C) DEGREE END SEMESTER EXAMINATION
AUGUST 2021
SUBJECT: ELECTROMAGNETIC WAVES (ECE - 2252)

TIME: 2 HOURS **MAX. MARKS: 40**

Instructions to candidates

- Answer any four full questions.
- Missing data may be suitably assumed.

1A. Represent the vector fields $\mathbf{B} = y\mathbf{a_x} - x\mathbf{a_y} + z\mathbf{a_z}$, $\mathbf{F} = (2x+y)\mathbf{a_x} - (y-4x)\mathbf{a_y}$, and $\mathbf{G} = 10\mathbf{a_x} - 8\mathbf{a_y} + 6\mathbf{a_z}$ in cylindrical coordinate system.

1B. Given two vector fields $x^2\mathbf{a_x}$ and $xy\mathbf{a_x}+y^2\mathbf{a_y}$, determine the cross product between them.

(7+3)

2A. Given the electric flux density $\mathbf{D} = 6\rho\sin(\varphi/2)\mathbf{a_\rho}+1.5\rho\cos(\varphi/2)\mathbf{a_\varphi}$ C/m^2, evaluate both sides of the divergence theorem for the region $\rho = 2$m, $0 < \varphi < \pi$, and $0 < z < 5$m.

2B. Find the flux density at a point (2m, -3m, 6m) due to (a) a point charge of 5mC at (-2m, 3m, -6m), (b) a uniform line charge of $\rho_L = 20$mC/m on the x- axis, and (c) a uniform surface charge of density $\rho_S = 220\ \mu$C/m^2 on the $z = -5$m plane.

(5+5)

3A. Let the electric potential in a region be $100\rho\cos(\varphi)/(z^2+1)$ V. Find the electric field and volume charge density at (1.5m, 2.6m, 2m).

3B. Derive an expression for the energy stored in a discrete charge configuration comprising of point charges. Extend the analysis to a case of continuous volume charge distribution.

(5+5)

4A. Evaluate both sides of the Stokes theorem for the surface $r = 5$m, $0 < \theta < 60^0$, and $0 < \varphi < 72^0$ and for the magnetic field $\mathbf{H} = 8r\sin(\varphi)\mathbf{a_r}+21r\sin^2(\theta)\cos(\varphi)\mathbf{a_\varphi}$ A/m.

4B. A current filament of 5A in the $\mathbf{a_y}$ direction is parallel to y-axis at $x = 2$m, $z = -2$m. Find the magnetic field $\mathbf{H}$ at the origin.

(7+3)

5A. Show that for a uniform plane wave, electric as well as magnetic fields cannot have components along the direction of propagation.

5B. Derive expressions for transmittance and reflection coefficient for oblique incidence of *s*-polarized uniform plane wave impinging on an interface between two different dielectrics.

(4+6)

6A. Starting from an infinitesimal section of a transmission line, derive the transmission line equations and discuss their solutions.

6B. Derive expressions for the circular arcs which comprise the Smith Chart.

(5+5)