Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
Manipal University

THIRD SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION - NOV/DEC 2016

SUBJECT: ELECTROMAGNETIC WAVES (ECE - 2102)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. Starting from Gauss law, state and prove Gauss divergence theorem.

1B. Transform the vector $\mathbf{B} = y\mathbf{a}_x - x\mathbf{a}_y + z\mathbf{a}_z$ to cylindrical coordinates. Hence find **B** at $(5, 45^0, 2)$.

1C. Given the vector $10\mathbf{a}_x$, represent it in spherical coordinates at the point P (-3, 2, 4).

(5+3+2)

2A. Derive Poisson's and Laplace's equations in the context of static electromagnetic fields. In cylindrical coordinates, $V = 75$V at $\rho = 5$ mm and $V = 0$V at $\rho = 60$ mm. Determine the voltage at $\rho = 30$ mm if the potential depends only on ρ and medium is assumed to be homogeneous.

2B. Show that the potential at the origin due to a uniform surface charge density ρ_s spread over an annular disc located with its centre at z = 0 and with $(R)_m \leq \rho \leq (R+1)_m$ is independent of value of R.

2C. State Coulomb's law for point charges and define electric field intensity.

(5+3+2)

3A. Given $\mathbf{H} = 8r\sin(\phi)\mathbf{a}_r + 21r\sin^2(\theta)\cos(\phi)\,\mathbf{a}_\phi$, verify stokes theorem for the surface $r = 5$, $0 < \theta < 36^o$ and $0 < \phi < 72^o$.

3B. Starting from current density, derive the current continuity equation and hence, the relaxation time.

3C. Define the terms electric potential and potential difference

(5+3+2)

4A. Derive the boundary conditions for magnetic field. A current sheet $\mathbf{K} = -9\mathbf{a}_y$ A/m is located at $z = 0$. If for $z < 0$, the relative permeability is 4 and for $z > 0$ it is 3, determine **H** in the region $z < 0$. Given: **H** in the region $z > 0$ is $14.5\mathbf{a}_x + 8\mathbf{a}_z$ A/m

4B. Explain the concept of total internal reflection of EM wave. Obtain the expression for critical angle for total internal reflection.

4C. Two uniform line charges of density 4 nC/m lie in the $x = 0$ plane at $y = 4$ m and $y = -4$ m. Determine **E** at $(4, 0, 10)_m$.

(5+3+2)

5A. Starting from Maxwell equations, derive wave equation for sinusoidal plane wave propagating in free space. Hence obtain expressions for Electric and Magnetic fields. Assume that propagation is in positive z-direction and Electric field has component only in one of the transverse directions.

5B. A parallel polarized (p-polarized) EM wave is incident at oblique angle on the interface separating two perfect dielectric media. Derive expression for reflection coefficient.

5C. A circular current loop of radius r and current I lies in the $z = 0$ plane. Find the torque which results if the current is in the $\mathbf{a}_\phi$ direction and there is a uniform field $\mathbf{B} = B_o(\mathbf{a}_x + \mathbf{a}_z)/\sqrt{2}$.

(5+3+2)