Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
A Constituent Institution of Manipal University

THIRD SEMESTER B.TECH. (E & C) DEGREE END SEMESTER EXAMINATION
NOVEMBER 2018

SUBJECT: ELECTROMAGNETIC WAVES (ECE - 2102)

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

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

1A. In a nonmagnetic medium ($\mu_r = 1$) the electric field component is $\vec{E} = 4\sin(2\pi \times 10^7 t - 0.8x)\overrightarrow{a_z}$ V/m, Determine the total power crossing the surface of area 20 cm^2 in the $\overrightarrow{a_x}$ direction.

1B. A uniform plane wave propagating through the medium with loss tangent 0.53, $\varepsilon_r = 8$, $\mu_r = 2$ has $\vec{E} = 0.5e^{-z/3}\sin(10^8 t - \beta z)\ \vec{a}_x$ V/m, determine β and $\vec{H}$.

1C. For a good conducting medium having $\sigma = 58\ MS/m$, $\mu_r = 1$ and $\varepsilon_r = 1$ at a frequency of 100 MHz, calculate the intrinsic impedance (η), propagation constant (γ) and skin depth (δ).

(4+3+3)

2A. Given $\vec{E} = E_0\sin(10^6 t - \beta z)\overrightarrow{a_x}$ V/m in free space. Determine wavelength, expressions for $\vec{D}, \vec{B}$ and $\vec{H}$ at t = 1μS.

2B. (i) Find the distance between two points A (10, 30^0, 50^0) and B (7, 45^0, 90^0).

(ii) The magnetic flux density is given as $\vec{B} = \frac{4}{\rho}\overrightarrow{a_\emptyset}$ T in cylindrical coordinates. Determine the magnetic flux crossing the plane surface defined by $1m < \rho < 2.5m$, $0 < z < 2m$ and $\emptyset = \pi/4$.

2C. Derive the modified amperes circuit law for a time varying field.

(4+3+3)

3A. Write the expressions for incident wave ($\overrightarrow{E_{is}}$, $\overrightarrow{H_{is}}$), reflected wave ($\overrightarrow{E_{rs}}$, $\overrightarrow{H_{rs}}$), and transmitted wave ($\overrightarrow{E_{ts}}$, $\overrightarrow{H_{ts}}$), for a uniform plane wave propagating along positive z direction and incident normally at the boundary z = 0 between two perfect dielectrics. Assume that $\overrightarrow{E_{is}}$, $\overrightarrow{E_{rs}}$ and $\overrightarrow{E_{ts}}$ have polarized along $\overrightarrow{a_x}$ direction and medium 1 (z < 0), medium 2 (z > 0) are characterised by (ε_1, μ_0) and (ε_2, μ_0) respectively.

3B. Use Ampere's circuital law to find the magnetic field intensity $\vec{H}$ at $\rho < a$ and at $a < \rho < b$ for a coaxial cable of length l consisting of two concentric cylinders of radius a and b separated by free space. Assume current I is flowing in $\overrightarrow{a_z}$ direction in inner conductor and -$\overrightarrow{a_z}$ direction in outer conductor.

3C. Derive the expression for total internal reflection.

(4+3+3)

4A. The magnetic flux density in free space is given as $\vec{B} = 0.4\,\overrightarrow{a_x} + 0.2\,\overrightarrow{a_y} - 0.3\,\overrightarrow{a_z}$ T. A rectangular loop carrying current of 20 mA in counter clock direction lies in z = 0 plane and is bounded by x=1m, x=3m, y=2m and y=5m. Find the force acting on each segment and hence the total torque acting on the loop.

4B. If magnetic vector potential is $\vec{A} = -\left(\frac{\rho^2}{4}\right)\overrightarrow{a_z}$ A/m, determine the total flux crossing the surface $\varphi = \pi/2, 1\text{m} \leq \rho \leq 2\text{m}, 0 \leq z \leq 5\text{m}$.

4C. A circular disk of radius *d* is uniformly charged with surface charge density of $\rho_s\ C/m^2$. The disk lies on the *z* = 0 plane with its axis along the *z* axis. Determine the expression for electric field intensity $\vec{E}$ at point (0, 0, h).

(4+3+3)

5A. Derive the expression for reflection and transmission coefficient for a uniform plane wave at oblique incidence with $\vec{E}$ parallel to the plane of incidence.

5B. Given that $\vec{H}_1 = -2\vec{a}_x + 6\vec{a}_y + 4\vec{a}_z\ A/m$ in region 1 (z > 0) where $\mu_1 = 5\mu_0$. If the interface carries current $\vec{K} = 80\,\overrightarrow{a_x}$ A/m on the surface z = 0. Determine $\vec{H}_2$ and $\overrightarrow{B_2}$ in region 2 (z < 0) filled with $\mu_2 = 3\mu_0$.

5C. Light is incident from air to glass at Brewster angle. Refractive index of glass is 1.45. Determine the incident and transmitted angles.

(4+3+3)