Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

THIRD SEMESTER B. TECH. (E & C) DEGREE END SEMESTER EXAMINATION
DECEMBER 2018/JANUARY 2019
SUBJECT: ELECTROMAGNETIC WAVES (ECE - 2102)

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

Instructions to candidates

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

1A. Given that $\vec{D} = 30\, e^{-\rho}\overrightarrow{a_\rho} - 2z\,\overrightarrow{a_z}$ C/m^2 in cylindrical coordinates, evaluate both side of the Gauss divergence theorem for the volume enclosed by, $0 \le \rho \le 2m$, $0 \le z \le 5m$ and $0 \le \varphi \le 2\pi$.

1B. Derive the capacitance of a parallel plate capacitor using Laplace equation. The capacitor is formed by the two conducting plates placed at z= 0 with potential V and at z = d with potential 0. Assume the area of each plate is S and the region between the plates are filled with dielectric material of permittivity ε.

1C. Verify Stokes theorem for $\vec{H} = 6xy\,\overrightarrow{a_x} - 3y^2\overrightarrow{a_y}$ A/m around the rectangular path $0 < x < 2m, -2m < y < 1m, z = 0$. Assume $\overrightarrow{dS} = dS\,\overrightarrow{a_z}$.

(4+3+3)

2A. Derive the wave equations using Maxwell's equations and obtain its solution in free space.

2B. Derive an expression for the electric field intensity $\vec{E}$ at a distance ρ from an infinite line charge of ρ_l C/m charge density placed along the z axis.

2C. A conducting circular loop of radius 20 cm lies in the z = 0 plane in a magnetic field $\vec{B} = 10\cos(377t)\,\overrightarrow{a_z}\ mWb/m^2$. Calculate the induced voltage in the loop.

(4+3+3)

3A. A plane wave travelling from free space $(z < 0)$ to a lossless medium $(z > 0)$ characterised by $\mu = 3\mu_0$ and $\varepsilon = 2\varepsilon_0$. If the wave is incident normally at the boundary z = 0 with $\overrightarrow{H_i} = 10\cos(10^8 t - \beta z)\overrightarrow{a_x}\ mA/m$, determine the reflected wave $(\overrightarrow{E_r}, \overrightarrow{H_r})$ and transmitted wave $(\overrightarrow{E_t}, \overrightarrow{H_t})$ components.

3B. An electromagnetic wave is travelling in free space with its electric component $\vec{E} = 50\cos(3\times 10^8 t - z)\overrightarrow{a_y}$ V/m. Determine $(\vec{\nabla}\times\vec{H})$ and frequency (f).

3C. A 9.4 GHz uniform plane wave with maximum magntic field amplitude of 7 mA/m is propagating in polyethylene ($\varepsilon_r = 2.26$, $\mu_r = 1$). Find phase constant, velocity of propagation and intrinsic impedence.

(4+3+3)

4A. Derive the Poynting vector from first principles.

4B. (i) Find the distance between two points A (10, 5, 4) and B (5, 7, 9).

(ii) Derive the current continuity equation.

4C. The current density in a given region is $\vec{J} = 2\frac{e^{-5}}{\rho^2}\,\overrightarrow{a_\rho}$ A/m^2. Calculate the amount of current passing through the surface defined by $\rho = 4m$, $0 \le z \le 2m$, and $0 \le \emptyset \le 2\pi$.

(4+3+3)

5A. Write the expressions for incident wave, reflected wave and transmitted wave components of $\vec{E}$ and $\vec{H}$ respectively for a uniform plane wave incident at oblique incidence with $\vec{E}$ parallel to the plane of incidence.

5B. A uniform plane wave $\vec{E} = 100\cos(\omega t - 5z)\,\overrightarrow{a_y}\,\frac{\mathrm{V}}{\mathrm{m}}$ is travelling from a lossless medium $(\mu = 3\mu_0, \varepsilon = 2\varepsilon_0)$ to free space (z > 0). If it is incident normally on the interface z = 0, find the reflection coefficient (Γ), transmission coefficient (τ) and standing wave ratio (SWR).

5C. Derive the expression for total internal reflection.

(4+3+3)