Ref. No: Ex/ET/T/211/2017

B.E. (ETCE) 2nd YEAR EXAMINATION 2018
(1st Semester)

ELECTRO MAGNETIC THEORY

Time: Three hours

Full Marks 100

Answer any *five* questions.
All questions carry equal marks.
Assume appropriate values for all universal physical constants.

1. (a) Find the area of the spherical shell of radius a and polar angle θ varying within limits $\alpha \leq \theta \leq \beta$. 7
   (b) What happens to this result when $\alpha=0$ and $\beta=\pi$? Explain with figures. 3
   (c) Determine an expression for $\nabla.\mathbf{A}$ using cylindrical coordinates. 10

2. (a) Describe how permittivity of an electrically isotropic medium is expressed. 4
   (b) Describe an experimental procedure to measure displacement density in an isotropic homogeneous medium. 4
   (c) Determine the potential distribution about a pair of infinitely long parallel wires of negligible cross section carrying equal but opposite charges per unit length. 6
   (d) Determine the nature of equipotential surfaces for this problem. 6

3. (a) Find the stored energy in a system of four identical point charges, Q=4nC, located at the corners of a square whose length of each side is 1m. 10
   (b) Find magnetic field intensity at a point distant h from the centre of a circular loop along its axis carrying current I and having radius a. 10

4. (a) Obtain appropriate expression for the density of stored energy in a toroidal coil. 10
   (b) A square loop in the xy-plane has dimensions w and l along x and y axes respectively. It is immersed in a magnetic field of flux density B in the x-direction. Find the net torque about the y-axis. 10

5. (a) Region 1 ($z<0$) has $\mu_{r1}=1.5$ while region 2 ($z>0$) has $\mu_{r2}=5$.
   $\mathbf{B}_1=2.40\mathbf{a}_x+10.0\mathbf{a}_z$ and $\mathbf{B}_2=25.75\mathbf{a}_x+10.0\mathbf{a}_z$.
   If the interface carries a current sheet, what is its density at the origin? 8
   (b) For uniform plane waves, establish that the mode of propagation is TEM. 12

6. (a) Define polarization of an electro magnetic wave. 2
   (b) Explain different polarizations with the electric field vector plotted at regular intervals of T/8, where T is the time period of the time harmonic fields. 6
   (c) Establishing the conditions for various polarizations, prove that elliptical is the most general form of polarization. 12

7. (a) At an interface between two dielectrics, obtain the reflection coefficient for horizontally polarized waves. 8
   (b) Repeat the same for vertically polarized waves. 8
   (c) Hence prove that the Brewster's angle phenomenon exists only for the case of vertical polarization. 4

8. Consider a source $(\mathbf{J},\rho)$ whose properties are represented by μ,ε and σ. Beginning with Maxwell's equations in phasor form, derive the differential equations

$$\nabla^2\mathbf{A}-\gamma^2\mathbf{A}= -\mu\mathbf{J}$$
$$\nabla^2 V-\gamma^2 V= -(\rho/\varepsilon)$$

where $\gamma=j\omega\mu(\sigma+j\omega\varepsilon)$. It is necessary to redefine the Lorentz gauge condition. 20