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Ref. No: Ex/ET/T/211/2017(S)

B.E. (ETCE) 2nd YEAR EXAMINATION 2017
(1st Semester Supplementary)
ELECTROMAGNETIC THEORY

Time: Three hours

Full Marks 100

Answer any *five* questions.
All questions carry equal marks.
Assume the values of physical constants as and when required.

1. (a) A vector is given in rectangular coordinate system as $\mathbf{A}=A_x\mathbf{i}+A_y\mathbf{j}+A_z\mathbf{k}$. Express it in polar coordinates. 8
   (b) Prove that
   i) $\nabla.(\nabla X\mathbf{A})=0$ 6
   ii) $\nabla X(\nabla V)=0$ for any arbitrarily chosen vector **A** and scalar V. 6

2. (a) State Faraday's law of electrostatic attraction in both CGS and SI systems. 4
   (b) Prove Gauss' law of electrostatics 6
   (c) Discuss the physical significance of its counterpart in magnetostatics. 4
   (d) Prove that on the surface of a perfect conductor $D_n=\rho_s$ with the symbols having their usual meanings. 6

3. (a) Write all Maxwell's equation in both integral and differential forms and show that the equation of continuity is implicitly contained therein. 10
   (b) Derive the Helmholtz wave equation in free space there from. 10

4. (a) Determine the magnetic field at the centre of a circular loop carrying a current I. 8
   (b) Establish the existence of magnetic vector potential and derive an appropriate expression for it. 12

5. (a) With the help of a toroidal coil, find out the density of energy storage in magnetic field. 10
   (b) Repeat the same for an electrostatic field. 10

6. (a) Earth is considered to be a good conductor if $|J_D|/|J_C|\leq 0.1$. Determine the highest frequency for which earth can be considered a good conductor. Assume $\sigma=5X10^{-3}$ mho/m and $\varepsilon=10\varepsilon_0$. 6
   (b) Also find out the depth of penetration in earth at that frequency. Derive the relations you use. 14

7. (a) State and prove Poynting's theorem. 10
   (b) A short vertical antenna produces effective field strength $E_{rms}=(E_\theta)_{rms}=100\sin\theta$ mV/m at points of distance 1 km from the antenna, where θ is the polar angle. Compute the total power radiated. 10

8. Write short notes on *any two* of the followings:
   (a) Elliptical polarization
   (b) Instantaneous, average and complex Poynting vectors
   (c) Surface impedance of conductors 10X2