BINDURA UNIVERSITY OF SCIENCE EDUCATION

FACULTY OF SCIENCE AND ENGINEERING

DEPARTMENT OF ENGINEERING AND PHYSICS

Bachelor of Science Honours Degree in Electronic Engineering

EEE 3201: ELECTROMAGNETIC THEORY

DURATION: 3 hours **TOTAL MARKS:** 100

INSTRUCTIONS
The paper contains **seven** questions each carrying **20** marks
Answer **3**questions from **SECTION A** and **2** questions from **SECTION B.**

SECTION A

1. a. Define a unit vector and state its significance in the vector representation. (3)
   b. Define a scalar and scalar field giving two examples for each. (4)
   c. Illustrate how you can transform vectors from one coordinate system to the other. (4)
   d. Define a dot product and explain its significance and applications (4)
   e. If two position vectors are given A= -2ax-5ay-4az and B=2ax+3ay+5az, find:
      i) $\overline{AB}$ (2)
      ii) $\bar{a}_A$ (1)
      iii) $\bar{a}_B$ (1)
      iv) $\bar{a}_{AB}$ (1)

2. a. Explain cylindrical co-ordinate system and state the differential elements in cylindrical co-ordinate system. (5)

b. Given the two points A(x=2, y=3, z=-1) and B(r=4, $\theta=25^{o}$,$\Phi=120^{o}$). Find the spherical coordinates of A, Cartesian coordinates of B and distance AB. (5)

c. Define the Laplacian of a scalar field and state its significance (5)

d. Find the Laplacian of the following scalar fields:

i) $W=e^{-z}\sin 2x\cosh y$ (2)

ii) $V=10r\sin 2\theta\cos\Phi$ (5) (3)

3. a. State Coulomb's law of force between any two point charges and state the units of force. (5)

b. Obtain an expression for total electric field intensity at a point due to an infinite number of point charges. (7)

c. Explain the procedure of obtaining $\bar{E}$ due to the line charge, surface charge and volume charge. (8)

4. a. Define electric field intensity $\bar{E}$. (3)

b. Find the total charge inside a volume having volume charge density as $15z^{3}e^{-0.3x}\sin\pi y$ (mC/m^{3}). The volume is defined between $-1\leq x\leq 1$, $0\leq y\leq 1$ and $2\leq z\leq 5$. (6)

c. A charge of + 10C is located at the point x=0 and y=1 and charge of -5C is at the point x=0 and y=-1, find the point on y axis at which net electric field intensity $\bar{E}=0$. (6)

d. A point charge of 20 nC is located at the origin. Determine the magnitude and direction of $\bar{E}$ at point (1,3,-4)m. (5)

SECTION B

5. a. State and prove the Gauss's law (4)

b. Derive the expression for electric flux density $\bar{D}$ due to a point charge using Gauss' law. (6)

c. Derive Maxwell's first equation as applied to electrostatics, using Gauss's law. (6)

d. Given $\bar{D}= 5x^{3}\bar{a}_{x}/2$ C/m^{2}, evaluate both sides of the divergence theorem for the volume of a cube 1m on an edge, centered at the origin and with edges parallel to the axes (4)

6. a. Verify that the potential field given below satisfies the Laplace's equation: $V=2x^2-3y^2+z^2$. (4)

b. If V=2V at x=1mm and V=0 at x=0 and volume charge density ρ_v is $-10^6\varepsilon_o C/m^3$ constant within the region between x=0 to x=1mm, calculate V at x=0.5mm and E_x at x=1mm in free space. (8)

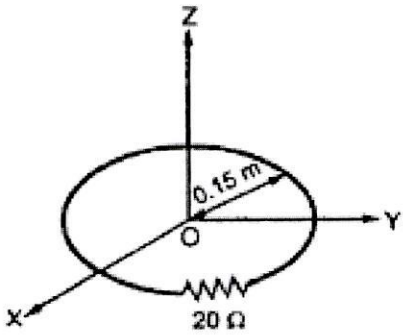
c. Let $V=2xy^2z^3$ and $\varepsilon=\varepsilon_o$. Given point P(1,3,-1), find V at point P. Also find out if V satisfies Laplace's equation. (3)

d. Derive Poisson's and Laplace's equations. (5)

7. a. i) Write Maxwell's equations in point form and integral form giving their physical significance (8)

ii) If the magnetic field $\bar{H}=[3x\cos\beta+6y\sin\alpha]\bar{a}_x$, find current density $\bar{J}$ if fields are invariant with time. (4)

b. The circular loop conductor having a radius of 0.15m is placed in X-Y plane. This loop consists of a resistance of 20Ω as shown below. If the magnetic flux density is $\bar{B}=0.5\sin10^3t\bar{a}_z T$, find current flowing through this loop. (6)



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