Roll No												

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1 EXAMINATION

Even Semester: 2021 - 22
Course Code: ECE 3004
Course Name: Electro Magnetic Theory
Program & Sem: B. Tech (ECE) & IV Sem

Date: 27th Apr 2022
Time: 11.30 AM to 12.30 PM
Max Marks: 30
Weightage: 15%

Instructions:
(i) Read the all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and Non-programmable calculators are permitted.

Part A [Memory Recall Questions]

Answer all the Questions. Each question carries 02 marks. (5Qx 2M= 10M)

1. If the two vectors A and B are having the coordinates (10, -4, 6) and (2, 1, 0) respectively, then the magnitude of $3\vec{A} - \vec{B}$ is

(a) 53.74 (b) 35.74 (c) 74.53 (d) 74.35 (C.O.No.1) [Knowledge level]

2. Two points P and Q are located at (0, 2, 4) and (-3, 1, 5), then the position vector P is

(a) $2\,\widehat{a_y} + 4\,\widehat{a_z}$ (b) $4\,\widehat{a_y} + 2\,\widehat{a_z}$ (c) $2\,\widehat{a_y} - 4\,\widehat{a_z}$ (d) $4\,\widehat{a_y} - 2\,\widehat{a_z}$ (C.O.No.1) [Knowledge level]

3. The Cartesian coordinates of the point P is (-2, 6, 3), then the corresponding Cylindrical coordinates of the point P is

(a) (63.2, 108.43^0, 3) (b) (63.2, 108.43^0, -3) (c) (6.32, 108.43^0, 3) (d) (6.32, 100.43^0, 3)

(C.O.No.1) [Knowledge level]

4. In cylindrical coordinate systems ρ can be expressed in terms Cartesian coordinate systems as

(a) $\sqrt{x^2 - y^2}$ (b) $\sqrt{x^2 + y^2}$ (c) $\sqrt{x^2 + y^2 + z^2}$ (d) $\sqrt{x^2 + y^2 - z^2}$ (C.O.No.1) [Knowledge level]

5. The divergence of a three dimensional vector $\vec{A}$ can be computed from the equation

(a) $\nabla \cdot \vec{A}$ (b) $\nabla \times \vec{A}$ (c) $\nabla \cdot (\nabla \times \vec{A})$ (d) $\nabla \times (\nabla \cdot \vec{A})$ (C.O.No.1) [Knowledge level]

Part B [Thought Provoking Questions]

Answer both the Questions. Each question carries 05 marks. (2Qx5M=10M)

6. A river flows south-east at 10 km/hr and a boat flows upon it with its bow pointed in the direction of travel. A man walks upon the deck at 2 km/hr in a direction to the right and perpendicular to the direction of boat's movement. Find the velocity of the man with respect to earth.
(C.O.No.1) [Comprehension level]

7. A person rides a bike 10 km in the direction 30^0 (counter clockwise from the x-axis) then changes his direction to 150^0 (counter clockwise from the x-axis) and rides for 20 km. Find his net displacement vector? (C.O.No.1) [Comprehension level]

Part C [Problem Solving Questions]

Answer the following Question. Question carries 10 marks. (1Qx10M=10M)

8. If the three vectors are $\vec{A} = (1, 2, 3)$, $\vec{B} = (3, 2, 1)$ and $\vec{C} = (1, 3, 2)$. Find $\vec{A} \times (\vec{B} \times \vec{C})$ and verify your answer using bac-cab rule? (C.O.No.1) Comprehension level]

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TEST 2

Winter Semester: 2021 - 22
Course Code: ECE 3004
Course Name: Electromagnetic Theory
Program & Sem: B. Tech (ECE) & IV Sem

Date: 2nd June 2022
Time: 11:30 AM to 12:30 PM
Max Marks: 30
Weightage: 15%

Instructions:
(iv) Read the all questions carefully and answer accordingly.
(v) Scientific calculators are allowed. ***Programmable calculators are not allowed***
(vi) All physical quantities may be assumed to be in SI units unless or otherwise specified

Part A [Memory Recall Questions]

Match the following **(5Qx 2M= 10M) (C.O.No.2) [Knowledge]**

1. Laplace equation	A. $\nabla \cdot \vec{D} = \rho_v$
2. Gauss's law of magnetostatics	B. H/m
3. Gauss's law of electrostatics	C. $\varepsilon \vec{E}$
4. Magnetic permeability	D. No magnetic monopole
5. Electric flux density	E. $\nabla^2 V = 0$

Part B [Thought Provoking Questions]

Answer both the Questions. Two questions carries ten marks. **(6M+4M=10M)**

6 The electric field intensity is defined at each point in space as the force (per unit charge) that would be experienced by a vanishingly small positive test charge if held at that point.

(i) Write down the expressions for electric field at a distance r for each of the following charge distributions:

(a) Point charge (Q)

(b) Line charge (ρ_L)

(c) Surface charge (ρ_S)

(d) Volume charge (ρ_v)

(ii) Two point charges $3\ nC$ and Q_2 are located at (2, -3, 1) and (0, 0, -1) respectively. If the *x*-component of the E-field is 0 at (-1,1,0), find the magnitude of Q_2 .

[6] (C.O.No.2) [Comprehension]

7 It is known that the force experienced by a charge *q* in a uniform electric field is $q\vec{E}$. Suppose a charge *Q* is placed in a static, uniform electric field.
(i) If this charged is moved in a closed loop (i.e. the initial and the terminal points of the loop is the same), what is the work done in moving the charge?
(ii) This work done is also the potential difference between the two points. Write down the expression for potential difference between the two points. You may consider the points as A and B.
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[**4**] (C.O.No.2) Comprehension)

Part C [Problem Solving Questions]

Answer the Question. The question carries tem Marks. (1QX10M=10M)

8 Showing all the necessary steps, find an expression for E-field at a distance r due to a line of uniform charge ρ_L and length L. What is the expression for E-field when $L \to \infty$? Verify the last result using Gauss's law. (C.O.No.2) Comprehension)

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END TERM EXAMINATION

Winter Semester: 2021 - 22
Course Code: ECE 3004
Course Name: Electromagnetic Theory
Program & Sem: B. Tech (ECE) & IV Sem

Date: 1st July 2022
Time: 09:30 AM to 12:30 PM
Max Marks: 100
Weightage: 50%

Instructions:

(vii) Read the all questions carefully and answer accordingly.
*(viii) Scientific calculators are allowed. **Programmable calculators are not allowed***
(ix) All physical quantities may be assumed to be in SI units unless or otherwise specified

Part A [Memory Recall Questions]

Match the following **(15Qx 2M= 30M)** [Knowledge]

6. Volume of a cuboid with sides $\vec{A}$, $\vec{B}$ and $\vec{C}$ **(C.O.No.1)**	F. Law of conservation of charge
7. Gradient of a curl of a vector **(C.O.No.1)**	G. $\sigma \longrightarrow \infty$
8. Gaussian surface for a charged sheet (infinite dimensions) **(C.O.No.2)**	H. $E_{t_1} = E_{t_2}$
9. Equation of continuity **(C.O.No.2)**	I. $\vec{A} \cdot (\vec{B} \times \vec{C})$
10. Static electric field **(C.O.No.2)**	J. F/m
11. Dielectric-dielectric boundary **(C.O.No.2)**	K. Null (zero)
12. Ampere's circuital law **(C.O.No.3)**	L. Sphere
13. Faraday's law of EM induction **(C.O.No.3)**	M. Cuboid
14. "*BAC-CAB*" rule **(C.O.No.1)**	N. $\sigma = 0$
15. Conductor-dielectric boundary **(C.O.No.1)**	O. No moving charges
16. Perfect conductors **(C.O.No.2)**	P. Spherical coordinate system
17. Perfect dielectrics **(C.O.No.2)**	Q. $\nabla \times \vec{H} = \vec{J}$
18. Gaussian surface for a point charge **(C.O.No.2)**	R. Tangential component of E-field is 0
19. SI unit of ε **(C.O.No.2)**	S. $\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$
20. $\hat{a}_r, \hat{a}_\theta, \hat{a}_\phi$ **(C.O.No.1)**	T. Vector triple product

Part B [Thought Provoking Questions]

Answer all the Questions. Each question carries TEN marks. (5Qx 10M= 50M)

Q.NO.16 The potential function V is of the form $V = xyz$. Does this potential satisfy the Laplace's and Poisson's equation? What is the expression for E-field due this potential at $P\ (1, 2, 3)$?

(C.O.No.2) [Comprehension]

Q.NO.17 Given a vector function $\vec{F} = (x + 3y - C_1 z)\hat{a}_x + (C_2 x + 5z)\hat{a}_y + (2x - C_3 y + C_4 z)\hat{a}_z$. Determine the constants C_1, C_2, C_3 and C_4 is the function is both solenoidal and irrotational.

(C.O.No.1) [Comprehension]

Q.NO.18 Three charges Q_1, Q_2 and Q_3 of magnitude $+q$ are situated at the three corners of a square of side *b*. Calculate the net electric field produced at the fourth corner of the square.

(C.O.No.2)[Comprehension]

Q.NO.19 If the magnetic field intensity $\vec{H}$ on a plane $z = 1$ is given by $\vec{H} = -y(x^2 + y^2)\hat{a}_x + x(x^2 + y^2)\hat{a}_y + \sin z\ \hat{a}_z$. Find the net current enclosed by the rectangular region bounded by $-1 \leq x \leq 1$ and $-2 \leq y \leq 2$ using Ampere's circuital law. (C.O.No.3) [Comprehension]

Q.NO.20 A potential field is given by $V=x^2+y^2+z^2$. Let a point P (*1, 1, 1*) be located at the boundary between conductor and free-space. Find the magnitude of the following at the point P:

(i) Electric potential V

(ii) Net electric field vector $\vec{E}$

(iii) Normal component of electric field E_n

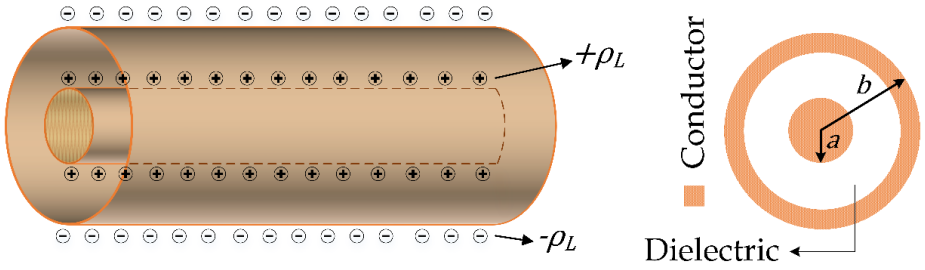
(iv) Tangential component of electric field E_t

(v) Surface charge density ρ_S at the boundary

Part C [Problem Solving Questions]

Answer all the Questions. Each question carries TEN marks (2Qx10M=20M)

Q.NO.21 A coaxial cable is an important component in microwave engineering and is frequently used to carry high frequency signals for broadband internet, antennas, cable televisions, just to name a few. The figure below shows a coaxial cable comprising of an inner conductor (of radius a) surrounded by a dielectric and encased in a metallic jacket (of radius b). Assume the charge density on the inner and outer conductors to be $+\rho_L$ and $-\rho_L$ (Coloumb/metre) and the permittivity of the dielectric medium to be ε (Farad/metre). Using Gauss's law, arrive at expression for the electric field at various regions of the coaxial cable. (C.O.No.2) [Comprehension]



Q.NO.22 The surface current density due to flow of charges in a small region is given by

$$\vec{J} = \left(x^2\hat{a}_x + y^2\hat{a}_y + z^2\hat{a}_z\right)\left(\frac{A}{m^2}\right)$$

Find the rate of change charge-density at each of the following points (C.O.No.2)[Comprehension]

a) $(0.02,\ 0.01, 0.01)$
b) $(0.02, -0.01, -0.01)$
c) $(-0.02, -0.01, 0.01)$