GUJARAT TECHNOLOGICAL UNIVERSITY

BE-4 SEMESTER – OLD PAPER – S22 TO W25 – QUESTION BANK

Subject Name & Code:
Electromagnetic Theory (3141009)

Chapter 1: Review of Vector Calculus

Repeated Questions:

1. **Define and explain: Divergence, Gradient, and Curl.**
   - Appeared in:
     - W25 (Q1a, 03 marks)
     - W23 (Q1a, 03 marks)
     - S23 (Q1a, 03 marks)
2. **Prove that divergence of curl of any vector field is zero.**
   - Appeared in:
     - W25 (Q1b, 04 marks)
     - S25 (Q5b, 04 marks)
     - W24 (Q3a, 03 marks)
3. **Transform vectors between coordinate systems (Cartesian, Cylindrical, Spherical).**
   - Appeared in:
     - S24 (Q1b, 04 marks)
     - S23 (Q2a, 03 marks)
     - W22 (Q5b, 04 marks)
4. **Compare Cartesian and Cylindrical coordinate systems.**
   - Appeared in:
     - S25 (Q1b, 04 marks)
     - W25 (Q4a, 03 marks)

Other Important Questions:

1. **Explain the difference between scalar and scalar field with example.**
   - W24 (Q1a, 03 marks)
2. **Explain the position vector and distance vector with example.**
   - W24 (Q1b, 04 marks)
3. **Explain the various types of charge distributions and charge density.**
   - W24 (Q1c, 07 marks)
4. **Calculate the volume of a sphere of radius R using integration.**
   - W24 (Q2a, 03 marks)
5. **Find the rectangular coordinates from given cylindrical coordinates.**
   - S22 (Q1b, 04 marks)
6. **Explain the gradient of a scalar. Write fundamental properties of gradient.**
   - S24 (Q1c, 07 marks)
7. **Explain vector vs. vector field with example.**
   - S23 (Q1a, 03 marks)
8. **Write applications of dot product and vector product.**
   - S23 (Q1b, 04 marks)
9. **Prove that curl of gradient of any scalar is zero.**
   - S25 (Q4b, 04 marks)
   - W22 (Q4b, 04 marks)
10. **Define field, dot product, and cross product.**
    - S24 (Q1a, 03 marks)

Chapter 2: Overview of Electrostatic & Steady Magnetic Fields

Repeated Questions:

1. **State and explain Coulomb's law.**
   - Appeared in:
     - S24 (Q2a, 03 marks)
     - W23 (Q2a, 03 marks)
2. **State and explain Gauss's law.**
   - Appeared in:
     - S25 (Q5b, 04 marks)
     - W25 (Q2b, 04 marks)
     - S22 (Q3b, 04 marks)
     - S23 (Q3a, 03 marks)
3. **Derive electric field due to infinite line charge.**
   - Appeared in:
     - S25 (Q1c, 07 marks)
     - S24 (Q3a, 03 marks)
     - S23 (Q1c, 07 marks)
     - W23 (Q2c, 07 marks)
4. **State and explain Biot-Savart's law.**
   - Appeared in:
     - S25 (Q4a, 03 marks)
     - W22 (Q2a, 03 marks)
     - W25 (Q5b, 04 marks)
5. **State and prove Ampere's circuital law.**
   - Appeared in:
     - S25 (Q2c, 07 marks)
     - S22 (Q3a, 03 marks)
     - W22 (Q1c, 07 marks)
6. **Explain Lorentz Force equation.**
   - Appeared in:
     - S25 (Q1a, 03 marks)
     - W25 (Q5a, 03 marks)
     - S23 (Q4a, 03 marks)

Other Important Questions:

1. **Derive expression for electric field due to surface charge distribution.**
   - W25 (Q1c, 07 marks)
2. **Derive expression for electric field due to volume charge distribution.**
   - S23 (Q2b, 04 marks)
3. **Find electric field intensity at a point due to multiple charge distributions.**
   - S25 (Q3c, 07 marks)
   - S24 (Q2c, 07 marks)
   - S23 (Q3c, 07 marks)
4. **Explain electric field intensity and potential gradient.**
   - S24 (Q3b, 04 marks)
   - S23 (Q3b, 04 marks)
5. **Find potential and potential difference from given electric field.**
   - S24 (Q3b, 07 marks)
6. **State and explain Faraday's law.**
   - S24 (Q4c, 07 marks)
   - W22 (Q3a, 03 marks)
7. **State and explain divergence theorem.**
   - S25 (Q3a, 03 marks)
   - W24 (Q3b, 04 marks)

8. **State and explain Stoke's theorem.**
    - S25 (Q3a, 03 marks)
    - S22 (Q4b, 04 marks)
9. **Define equipotential surface.**
    - S24 (Q3a, 03 marks)
10. **Explain magnetic scalar and vector potentials.**
    - S23 (Q4a, 03 marks)
11. **Derive continuity equation.**
    - S25 (Q3b, 04 marks)
    - W22 (Q3b, 04 marks)
12. **Find magnetic field using Biot-Savart law for given current distribution.**
    - S25 (Q4c, 07 marks)
    - S23 (Q4c, 07 marks)
    - W24 (Q4c, 07 marks)
13. **Calculate magnetic flux from given vector magnetic potential.**
    - S22 (Q4c, 07 marks)
    - W24 (Q4c, 07 marks)
14. **Explain conduction and convection current.**
    - S25 (Q4a, 03 marks)
15. **Explain spherical coordinate system.**
    - S25 (Q4b, 04 marks)
    - W22 (Q5a, 03 marks)
16. **Explain cylindrical coordinate system.**
    - S23 (Q3a, 03 marks)
    - W22 (Q5a, 03 marks)
17. **Compare spherical and cylindrical coordinate systems.**
    - S22 (Q4a, 03 marks)
18. **Find dot products between unit vectors in different coordinate systems.**
    - S22 (Q2a, 03 marks)
19. **Explain the physical significance of divergence with examples.**
    - S22 (Q1c, 07 marks)

Chapter 3: Time Varying Fields and Maxwell's Equations

Repeated Questions:

1. **Write Maxwell's equations in point form and integral form.**
   - Appeared in:
     - S24 (Q4b, 04 marks)
     - W23 (Q3a, 03 marks)
     - S23 (Q5a, 03 marks)
2. **Write Maxwell's equations in differential and integral form for static electric and magnetic fields.**
   - Appeared in:
     - S25 (Q3a, 03 marks)
     - W25 (Q3a, 03 marks)
     - W22 (Q3b, 04 marks)
3. **Explain the concept of retarded potential.**
   - Appeared in:
     - S25 (Q2a, 03 marks)
     - W22 (Q5b, 04 marks)
4. **Explain displacement current.**
   - Appeared in:
     - W23 (Q5a, 03 marks)
5. **State and explain Faraday's law.**
   - Appeared in:
     - S24 (Q4c, 07 marks)
     - W25 (Q4b, 04 marks)
     - W23 (Q4c, 07 marks)

Other Important Questions:

1. **Derive the continuity equation from Maxwell's equations.**
   - W23 (Q4b, 04 marks)
2. **State and explain Poynting's theorem.**
   - W25 (Q2c, 07 marks)
   - W22 (Q3c, 07 marks)
3. **Explain the application of Poynting's theorem for total power leaving a volume.**
   - W25 (Q2c, 07 marks)
4. **Derive an equation for variation in flux by moving a loop in a static magnetic field.**
   - W25 (Q5a, 03 marks)
5. **Write and explain Maxwell's equations in integral form.**
   - W24 (Q5a, 03 marks)
6. **Explain the concept of potential gradient and its relation to electric field ($\mathbf{E = -\nabla V}$).**
   - W22 (Q4c, 07 marks)
7. **Explain Hall effect.**
   - S22 (Q5b, 04 marks)

Chapter 4: Uniform Plane Waves

Repeated Questions:

1. **Write a short note on wave propagation in good conductors.**
   - Appeared in:
     - S25 (Q3c, 07 marks)
     - W25 (Q3c, 07 marks)
     - W22 (Q4c, 07 marks)
2. **Explain wave polarization.**
   - Appeared in:
     - S23 (Q5b, 04 marks)
     - W24 (Q5b, 04 marks)
     - W23 (Q4a, 03 marks)
3. **Explain skin effect and skin depth.**
   - Appeared in:
     - S22 (Q4a, 03 marks)
     - S23 (Q5a, 03 marks)
     - W23 (Q5b, 04 marks)
     - W22 (Q1b, 04 marks)

Other Important Questions:

1. **Write a short note on electromagnetic waves in a perfect dielectric.**
   - S23 (Q5c, 07 marks)
2. **Write a short note on plane wave propagation in general dielectrics.**
   - S24 (Q4c, 07 marks)
3. **Write a short note on wave propagation in dielectrics.**
   - W23 (Q4c, 07 marks)
4. **Discuss plane wave propagation in general directions.**
   - W23 (Q5c, 07 marks)
5. **Explain the Poynting vector and power considerations.**
   - W24 (Q5a, 03 marks)
6. **Given electric field amplitude, find frequency, wavelength, and period.**
   - S24 (Q4a, 07 marks)

Chapter 5: Plane Waves at Boundaries and in Dispersive Media

Repeated Questions:

1. **Explain the reflection of a uniform plane wave at normal incidence.**
   - Appeared in:
     - S23 (Q4b, 04 marks)
     - W24 (Q4b, 04 marks)
     - S22 (Q4b, 04 marks)
2. **Explain VSWR and reflection coefficient.**
   - Appeared in:
     - S25 (Q3b, 04 marks)
     - W25 (Q4a, 03 marks)
     - W22 (Q3a, 03 marks)
3. **Write a short note on wave reflection from multiple interfaces.**
   - Appeared in:
     - S25 (Q5c, 07 marks)
     - W22 (Q5c, 07 marks)
4. **Write a short note on plane wave reflection at oblique incidence angles.**
   - Appeared in:
     - S25 (Q5c, 07 marks)
     - S22 (Q5c, 07 marks)
     - W22 (Q6c, 07 marks)

Other Important Questions:

1. **Derive and sketch the standing wave pattern when $\eta_1 < \eta_2$.**
   - W25 (Q2c, 07 marks)
2. **Explain pulse broadening in dispersive media.**
   - W25 (Q4c, 07 marks)
3. **Determine standing wave ratio in front of a dielectric plate.**
   - S24 (Q4a, 07 marks)
4. **Explain boundary conditions between two dielectric materials.**
   - W25 (Q4c, 07 marks)
5. **Explain magnetic boundary conditions between two different media.**
   - W25 (Q3b, 04 marks)

Chapter 6: Transmission Lines

Repeated Questions:

1. **Draw the equivalent circuit of a transmission line and derive its voltage and current equations.**
    - Appeared in:
        - S25 (Q2c, 07 marks)
        - W25 (Q3c, 07 marks)
        - W22 (Q3c, 07 marks)
2. **Write the applications of transmission lines.**
    - Appeared in:
        - S24 (Q5a, 03 marks)
        - W23 (Q5b, 04 marks)
        - S22 (Q5c, 07 marks)
3. **Explain voltage standing wave ratio (VSWR) with necessary equations.**
    - Appeared in:
        - S24 (Q5c, 07 marks)
        - S22 (Q5a, 03 marks)
        - W23 (Q5a, 03 marks)
4. **Explain impedance matching.**
    - Appeared in:
        - S24 (Q5b, 04 marks)
        - S22 (Q5b, 04 marks)
5. **Explain Smith Chart and its properties/uses.**
    - Appeared in:
        - S25 (Q2b, 04 marks)
        - W25 (Q5c, 07 marks)
        - S22 (Q5a, 03 marks)
        - W22 (Q2b, 04 marks)

Other Important Questions:

1. **Obtain the expression for impedance for a lossless transmission line terminated in a short circuit.**
    - S25 (Q4c, 07 marks)
    - W25 (Q4b, 04 marks)
2. **Define and explain characteristic impedance.**
    - S25 (Q5a, 03 marks)
    - W25 (Q4a, 03 marks)
3. **Write transmission line equations and their solutions in phasor form.**
    - S24 (Q5b, 04 marks)
    - S23 (Q5c, 07 marks)
    - S22 (Q5c, 07 marks)
4. **Write a short note on lossless and low-loss propagation.**
    - S24 (Q5c, 07 marks)
    - W25 (Q5c, 07 marks)
5. **Write a short note on lossless propagation.**
    - W23 (Q5c, 07 marks)
6. **Explain double stub impedance matching method.**
    - S23 (Q5b, 04 marks)
7. **Explain propagation constant and characteristic impedance of a transmission line.**
    - W24 (Q5b, 04 marks)

Numerical Questions (No Solutions Required):

1. **Given three infinite sheets of charge, find E at given points.**
    - S24 (Q2c, 07 marks)

- W23 (Q3b, 07 marks)

2. **Find electric field intensity at a point due to multiple charge distributions.**
   - S25 (Q3c, 07 marks)
   - S23 (Q3c, 07 marks)
3. **Find volume charge density from given D field.**
   - S23 (Q2c, 07 marks)
4. **Evaluate both sides of divergence theorem for a given D field.**
   - S23 (Q2c, 07 marks)
   - S22 (Q2c, 07 marks)
5. **Find potential and electric field from given potential function V.**
   - S23 (Q3c, 07 marks)
6. **Find H using Biot-Savart law for given current distribution.**
   - S25 (Q4c, 07 marks)
   - S23 (Q4c, 07 marks)
7. **Calculate total magnetic flux from given vector magnetic potential.**
   - S22 (Q4c, 07 marks)
   - W24 (Q4c, 07 marks)
8. **Find total electric field at origin due to given charge distributions.**
   - W22 (Q2c, 07 marks)
9. **Find gradient of given scalar fields.**
   - W23 (Q2b, 04 marks)
10. **Calculate D at a point due to point charge and line charge.**
    - W23 (Q3b, 04 marks)
11. **Find potential at a point due to given charge configurations.**
    - W23 (Q4b, 04 marks)
12. **Find H at a point due to current filament.**
    - W24 (Q4c, 07 marks)

****