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Vellore Institute of Technology

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CHENNAI

Reg. No 24BVD0104

## Final Assessment Test(FAT) - NOV/DEC 2025

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| Programme | B.Tech. | Semester | Fall Semester 2025-26 |
| Course Code | BEVD202L | Faculty Name | Prof. Saranya Nair M |
| Course Title | Electromagnetic Field Theory | Slot | A2+TA2 |
| | | Class Nbr | CH2025260100505 |
| Time | 3 hours | Max. Marks | 100 |

**Instructions To Candidates**

- Write only your registration number in the designated box on the question paper. Writing anything elsewhere on the question paper will be considered a violation.
- Answer all the questions.
- Use Smith Charts wherever required.

**Course Outcomes**

CO1: Evaluate and analyze Electric Fields and Electric Potential due to different Charge distributions.
CO2: Compute and analyze magnetic fields in different material media.
CO3: Understand the propagation of EM waves through time-varying Maxwell's equations
CO4: Comprehend the EM wave propagation in conducting as well as in dielectric materials.
CO5: Calculate the power of an EM wave while propagating through different materials.
CO6: Illustrate the wave mechanism in different transmission lines at high frequencies using transmission line parameters.

### Section - I

**Answer all Questions (4 × 7 Marks)**

01. Consider the vector given in cylindrical co-ordinates as, $\mathbf{A} = \rho \cos \varphi \, \mathbf{a}_\rho + \rho z^2 \sin \varphi \, \mathbf{a}_z$. Transform A into rectangular coordinates and calculate its magnitude at point (3, -4, 0).

**[7] (CO1/K3)**

02. A slab of dielectric material has a relative dielectric constant of 3.8 and contains a uniform electric flux density of 8 nC/m$^2$. If the material is lossless, find:
(a) Electric Field Intensity, E **[4 Marks]**
(b) Number of dipoles per cubic meter if the average dipole moment is $10^{-29}$ Cm **[3 Marks]**
**Note:** Value of Permittivity of free space is given as $8.854 \times 10^{-12}$ F/m.

**[7] (CO1/K3)**

03. A time-varying radial current density in free space is given by $\mathbf{J} = \frac{5e^{-10t}}{r} \mathbf{a}_r$ A/m$^2$, where 't' is in seconds and 'r' is the radial distance. At t = 0.1s, determine the total current passing through a spherical surface of radius r = 2m. Analyze, how the exponential time factor affects the instantaneous current.

**[7] (CO1/K4)**

04. Analyze and comment on the physical plausibility of the following vector field as either electrostatic or magnetostatic in free space. $\mathbf{F} = y^2 z \, \mathbf{a}_x + 2(x + 1) yz \, \mathbf{a}_y - (x + 1) z^2 \, \mathbf{a}_z$.

**[7] (CO2/K4)**

### Section - II

**Answer all Questions (4 × 8 Marks)**

05. A charge of q = 4 nC is placed in a region where the electric field intensity is given in cylindrical coordinates as: $\mathbf{E} = (z + 1) \sin \varphi \, \mathbf{a}_\rho + (z + 1) \cos \varphi \, \mathbf{a}_\varphi + \rho \sin \varphi \, \mathbf{a}_z$ V/m. Determine the work done in moving the charge from
( Each 2 Marks)
(a) A (1, 0, 0) to B (4, 0, 0)
(b) B (4, 0, 0) to C (4, 30°, 0)
(c) C (4, 30°, 0) to D (4, 30°, -2)
(d) Along the straight-line segment from A to D
Analyze the values and hence comment whether the work done depends on the path.

**[8] (CO1/K4)**

06. For a current distribution in free space, $\mathbf{A} = (2x^2y + yz)\,\mathbf{a}_x + (xy^2 - xz^3)\,\mathbf{a}_y - (6xyz - 2x^2y^2)\,\mathbf{a}_z$ Wb/m
(a) Calculate the magnetic flux density, **B**. **[4 Marks]**
(b) Find the magnetic flux through a loop described by $x = 1, 0 < y < 2, 0 < z < 2$. **[4 Marks]**

**[8] (CO2/K3)**

07. In a charge-free region, the material parameters are given as $\sigma = 0$, $\varepsilon = \varepsilon_0\varepsilon_r$, and $\mu = \mu_0$. The magnetic field in this region is described by $\mathbf{H} = 5\cos(10^9 t - 4y)\,\mathbf{a}_z$ A/m.
(a) Determine the displacement current density $\mathbf{J}_d$ in the medium. **[4 Marks]**
(b) Calculate the relative permittivity $\varepsilon_r$ of the medium. **[4 Marks]**

**[8] (CO3/K5)**

08. Sea water plays a vital role in the study of submarine communications. Assuming that for sea water, $\sigma = 4$ S/m, $\varepsilon_r = 80$, $\mu_r = 1$, and $f = 100$ MHz, calculate:( Each 2 Marks)
(a) the phase velocity, (b) the wavelength, (c) the skin depth, (d) the intrinsic impedance.

**[8] (CO4/K3)**

## Section - III

**Answer all Questions (4 × 10 Marks)**

09. In free space, $V = x^2y(z + 3)$ V. Find
(a) Electric Field Intensity, **E** at (3, 4, -6) **[4 Marks]**
(b) The charge enclosed within the cube of $0 < x, y, z < 1$. **[6 Marks]**

**[10] (CO1/K3)**

10. In a nonmagnetic material, $\mathbf{H} = 30\cos(2\pi \times 10^8 t - 6x)\,\mathbf{a}_y$ mA/m, find the time-average power crossing the surface $x = 1, 0 < y < 2, 0 < z < 3$ m.

**[10] (CO5/K3)**

11. A 30-Ω transmission line of length 3.6 mm is terminated in series load of resistance 40-Ω and inductance of 4-nH. The phase velocity in the transmission line is the velocity of light. Calculate the following parameters at 4 GHz using Smith chart.
(a) Reflection coefficient at the input and load **[4 Marks]**
(b) Input admittance **[3 Marks]**
(c) Distance of maxima and minima from the load **[3 Marks]**

**[10] (CO6/K5)**

12. A 75-Ω lossless line is to be matched to a (100 - j80) Ω load with a shorted stub. Using Smith chart, design the stub and calculate the stub length, its distance from the load, and the necessary stub admittance.

**[10] (CO6/K6)**

**BL-Bloom's Taxonomy Levels - (K1-Remembering,K2-Understanding,K3-Applying,K4-Analysing,K5-Evaluating,K6-Creating)**