# MUTHAYAMMAL ENGINEERING COLLEGE

(An Autonomous Institution)

(Approved by AICTE, New Delhi, Accredited by NAAC & Affiliated to Anna University)
Rasipuram - 637 408, Namakkal Dist., Tamil Nadu

Estd. 2000

## MUST KNOW CONCEPTS

**MKC**

**ECE**

**2021-2022**

**Course Code & Course Name : 19ECC05 & ELECTROMAGNETIC FIELDS**

**Year/Sem/Sec : II / III / A, B, C**

| S.No | Term | Notation (Symbol) | Concept/Definition/Meaning/Units/Equation /Expression | Units |
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| **Unit-I : Electrostatics** | | | | |
| 1 | Scalar Quantity | - | Characterized only by magnitude. Eg: mass, time, temperature & electric potential | - |
| 2 | Vector Quantity | - | Characterized by both magnitude and direction. Eg: force, velocity, electric field intensity & electric flux density. | - |
| 3 | Scalar multiplication | (.) | Dot product i.e., $\hat{A}.\hat{B}$ = AB Cosθ<br>It obeys commutative law i.e, A.B=B.A<br>If two vectors are said to be perpendicular to each other then its dot product is zero. | - |
| 4 | Vector Multiplication | (X) | Cross product i.e., $\hat{A}$ X $\hat{B}$ = ABSinθ and<br>$\hat{A}$ X $\hat{B}$ = - $\hat{B}$ X $\hat{A}$<br>If two vectors are said to be parallel to each other then its cross product is zero. | - |
| 5 | Differential vector operator | ▼ | $▼ = (\partial/\partial x)\,\hat{a}_x + (\partial/\partial y)\,\hat{a}_y + (\partial/\partial z)\,\hat{a}_z$ | - |
| 6 | Gradient | ▼V | $▼V = (\partial v/\partial x)\,\hat{a}_x + (\partial v/\partial y)\,\hat{a}_y + (\partial v/\partial z)\,\hat{a}_z$<br>▼V = grad V | - |
| 7 | Divergence | ▼.A | $▼.A = (\partial A_x/\partial x) + (\partial A_y/\partial y) + (\partial A_z/\partial z)$<br>▼.A= div A & divergence of a vector is scalar | - |
| 8 | Curl | ▼x A | $▼\text{x } A = [(\partial A_z/\partial_y) - (\partial A_y/\partial_z)]\,\hat{a}_x + [(\partial A_x/\partial_z) - (\partial A_z/\partial_x)]\,\hat{a}_y + [(\partial A_y/\partial_x) - (\partial A_x/\partial_y)]\,\hat{a}_z$<br>Curl indicates a measure of a vector to rotate. | - |
| 9 | Solenoidal | - | A vector is said to be solenoidal if its divergence is zero. | - |
| 10 | Irrotational | - | A vector is said to be iirotational if its curl is zero. | - |
| 11 | Unit vector | - | $\hat{a}_r$ = vector r / magnitude of r | - |
| 12 | Coordinate system | - | To describe a vector accurately and to express a vector in terms of its components, it is | - |

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| | | | necessary to have some reference directions. | |
| 13 | Divergence theorem | - | Converts the surface integral into a volume integral, provided that the closed surface encloses certain volume. $\iint_s F^{\wedge}. ds^{\wedge} = \iiint_v (\blacktriangledown . F^{\wedge})\, dv$ | - |
| 14 | Stokes theorem | - | Relates a line integral into a surface integral. $\int_L F^{\wedge}. dL^{\wedge} = \iint_s (\blacktriangledown \times F^{\wedge})\, ds^{\wedge}$ | - |
| 15 | Coulombs law | - | The force of attraction (or) repulsion between any two point charges is directly proportional to the product of two charges and inversely proportional to the square of the distance between them. $F = Q_1Q_2 / 4\pi\varepsilon r^2$ | - |
| 16 | Electric field intensity | E | Electric force per unit charge $E = F/q = Q / 4\pi\varepsilon r^2$ | Volts / Meter |
| 17 | Gauss law | - | Net flux passing through any closed surface is equal to the charge enclosed by that surface. Integral form : $\int_s D^{\wedge}.ds^{\wedge} = Q$ Differential form : $\blacktriangledown.D = \rho_v$ | - |
| 18 | Electric Potential | V | Potential difference between two points: $V = [(Q / 4\pi\varepsilon r_2) - (Q / 4\pi\varepsilon r_1)]$ | Volts |
| 19 | Absolute potential | V | Work done in moving a unit positive charge from infinity to a given point in an existing electric field. $V = (Q / 4\pi\varepsilon r)$ | Volts |
| 20 | Relation between E and V | - | Electric field strength at any point is negative of the potential gradient at that point. $E = - \blacktriangledown V$ | - |
| 21 | Electric Flux Density | D | Total flux per unit surface area. $D = [Q / 4\pi r^2]\, \hat{a}_r$ | Coulomb / Meter$^2$ |
| 22 | Poisson's equation | - | $\blacktriangledown^2 V = - [\rho_v / \varepsilon]$ charge enclosed by the region in terms of volume charge density is $\rho_v$ | - |
| 23 | Laplace's equation | - | $\blacktriangledown^2 V = 0$ Charge free region i.e., $\rho_v = 0$. | - |
| 24 | Capacitance | C | Capacitance of a parallel plate capacitor is $C = Q/V = A.\varepsilon_0.\varepsilon_r / d$ Where A = area of the plates, $\varepsilon_0 = 8.854\times10^{-12}$ free space permittivity of the medium, $\varepsilon_r$ = relative permittivity of the medium, d = distance between the plates. | Farads |
| 25 | Electrostatic Energy (or) Energy stored in a capacitor | W | $W = \frac{1}{2} CV^2$ (or) $W = \frac{1}{2} QV$ | Joules |
| **Unit-II : Magnetostatics** | | | | |
| 26 | Magnetic Flux | $\phi$ | Flux passing through any area | weber |

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| 27 | Magnetic Flux density | B | Magnetic flux density passing per unit area | Weber $/m^2$ |
| 28 | Biot - Savart's law | - | The magnetic field intensity $d\vec{H}$ at P can be written as $dH = \frac{IdlSin\alpha}{4\pi R^2}$ | Ampere/m |
| 29 | Ampere's Circuital Law | - | The line integral of the magnetic field $\vec{H}$ around a closed path is the net current enclosed by this path. $\oint \vec{H}.d\vec{l} = I_{enc}$ | - |
| 30 | Current density | J | Current per unit area | $A/m^2$ |
| 31 | Energy density | | Energy per volume | Joule/ $m^3$ |
| 32 | Torque | T | The tangential force multiplied by the radial distance at which it acts. | Newton |
| 33 | Magnetic Moment | m | The maximum torque on loop per unit magnetic flux density m=T/B | - |
| 34 | Magnetic dipole | M | M=IA | - |
| 35 | Magnetic Scalar potential | Vm | $Vm = - \int H.dl$ | - |
| 36 | Lorentz force equation | - | F= q(E + (vxB)) | - |
| 37 | Self Inductance | L | $L=N \phi/I$ | Henry |
| 38 | Mutual Inductance | M | $M= N_1 \phi_{21}/I_2$ | Henry |
| 39 | Coefficient of Coupling | K | Fraction of total flux produced by one coil linking a second coil. | No unit |
| 40 | Types of charge distribution | - | 1. Point charge, 2. Line charge, 3. Surface charge, 4. Volume charge | - |
| 41 | Point charge | - | Surface carrying charge is very small ie, point | - |
| 42 | Line charge | - | Charge uniformly distributed along line | - |
| 43 | Surface charge | - | Charge distributed uniformly over two dimensional surface. | - |
| 44 | Volume charge | - | Charge distributed uniformly in volume | - |
| 45 | Charge density of line charge | $\rho_L$ | $\rho_L$ = Total charge in coulomb/Total length in meter | - |
| 46 | Charge density of surface charge | $\rho_s$ | $\rho_s$ = Total charge in coulomb/Total area in square meters | - |
| 47 | Charge density of volume charge | $\rho_v$ | $\rho_v$ = Total charge in coulomb/Total volume in cubic meters | - |
| 48 | Electric field due to line charge | - | $\bar{\mathbf{E}} = \int_L \frac{\rho_l \, dl}{4\pi\varepsilon_0 R^2} \bar{a}_R$ | - |

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| 49 | Electric field due to surface charge | - | $\overline{\mathbf{E}} = \int_S \frac{\rho_S \, dS}{4\pi\varepsilon_0 R^2} \bar{a}_R$ | - |
| 50 | Electric field due to volume charge | - | $\overline{\mathbf{E}} = \int_{Vol} \frac{\rho_v \, dv}{4\pi\varepsilon_0 R^2} \bar{a}_R$ | - |
| **Unit-III : Time Varying Fields and Maxwell's Equations** | | | | |
| 51 | Faradays law | - | Total EMF induced in a circuit is equal to the rate of decrease of the total magnetic flux linking the circuit. $V = -d\phi/dt$ | - |
| 52 | Reluctance | R | $R = l/\mu A$ | meter |
| 53 | Conduction current | Ic | Current flows through a resistive element | Ampere |
| 54 | Displacement current | $I_D$ | Current flows through a capacitive element | Ampere |
| 55 | Maxwell's Equation I | - | $\nabla \times H = J + \partial D/\partial t$ | - |
| 56 | Maxwell's Equation II | - | $\nabla \times E = -\partial B/\partial t$ | - |
| 57 | Maxwell's Equation III | - | $\nabla . D = \rho$ | - |
| 58 | Maxwell's Equation IV | - | $\nabla . B = 0$ | - |
| 59 | Ampere's Circuital Law | - | The line integral of the magnetic field $\vec{H}$ around a closed path is the net current enclosed by this path. $\oint \vec{H}.d\vec{l} = I_{enc}$ | - |
| 60 | Gauss Law for electricity | - | $\oint E.dA = Q/\epsilon 0$ | - |
| 61 | Gauss Law for magnetism | - | $\oint B.dA=0$ | - |
| 62 | Faraday's Law | - | $\oint E.dl= d\varphi/ dt$ | - |
| 63 | Ampere-Maxwell Law | - | $\oint B.dl=\mu 0ic+\mu 0\epsilon 0(d\varphi/ dt)$ | - |
| 64 | Gauss's law | - | Electric charges produce an electric field. The electric flux across a closed surface is proportional to the charge enclosed. | - |
| 65 | Gauss's law for magnetism | - | There are no magnetic monopoles. The magnetic flux across a closed surface is zero. | - |
| 66 | Faraday's law | - | Time-varying magnetic fields produce an electric field. | - |

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| 67 | Ampère's law | - | Steady currents and time-varying electric fields (the latter due to Maxwell's correction) produce a magnetic field. | - |
| 68 | Maxwell's Equation I<br>Integral form | - | $\oint_{\partial\Sigma} \mathbf{B} \cdot d\boldsymbol{l} = \mu_0 \left( \iint_{\Sigma} \mathbf{J} \cdot d\mathbf{S} + \varepsilon_0 \frac{d}{dt} \iint_{\Sigma} \mathbf{E} \cdot d\mathbf{S} \right)$ | - |
| 69 | Maxwell's Equation II<br>Integral form | - | $\oint_{\partial\Sigma} \mathbf{E} \cdot d\boldsymbol{l} = -\frac{d}{dt} \iint_{\Sigma} \mathbf{B} \cdot d\mathbf{S}$ | - |
| 70 | Maxwell's Equation III Integral form | - | $\oiint_{\partial\Omega} \mathbf{E} \cdot d\mathbf{S} = \frac{1}{\varepsilon_0} \iiint_{\Omega} \rho \, dV$ | - |
| 71 | Maxwell's Equation IV Integral form | - | $\oiint_{\partial\Omega} \mathbf{B} \cdot d\mathbf{S} = 0$ | - |
| 72 | Maxwell's Equation I<br>phasor form | - | $\nabla \times \widetilde{\mathbf{H}} = \widetilde{\mathbf{J}} + j\omega\widetilde{\mathbf{D}}$ | - |
| 73 | Maxwell's Equation II<br>phasor form | - | $\nabla \times \widetilde{\mathbf{E}} = -j\omega\widetilde{\mathbf{B}}$ | - |
| 74 | Maxwell's Equation III phasor form | - | $\nabla \cdot \widetilde{\mathbf{D}} = \tilde{\rho}_v$ | - |
| 75 | Maxwell's Equation IV phasor form | - | $\nabla \cdot \widetilde{\mathbf{B}} = 0$ | - |
| **Unit-IV : Transmission Lines at Radio Frequencies** | | | | |
| 76 | Transmission Line | - | The electrical lines which are used to transmit the electrical wave along them are called as transmission lines. | - |
| 77 | Primary constants / Parameters | R,L,C and G | The constants which are assumed to be independent of frequency are called as primary constants. For a practical transmission line, the primary line constants are Resistance (R), Inductance (L), Capacitance (C) and Conductance (G). | R (Ω/km)<br>L (H/km)<br>C (Ω/km)<br>G (℧/km) |
| 78 | Secondary constants / Parameters | $Z_0$ , α and β | The parameters which change their value as the frequency changes are called as secondary constant. Characteristic impedance (Zo), propagation constant (α) and phase constant (β) are secondary constants. | $Z_0$ (ohm)<br>α (nepers /km)<br>β (rad/k m) |
| 79 | Distributed elements | - | The line parameters like R, L, C and G are not physically separable unlike circuit elements of lumped circuit. These parameters are | - |

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| | | | distributed all along the length of the transmission line. Hence, they are called as distributed elements. | |
| 80 | Characteristic impedance | $Z_0$ | The ratio of voltage applied and the current flowing is the input impedance of the line. The input impedance of the infinite line is called characteristic impedance. | $Z_0$ (ohm) |
| 81 | Attenuation constant | α | It is the rate at which the signal gets attenuated along the line. | α (nepers /km) |
| 82 | Phase constant | Β | It is the rate at which phase of the signal gets changed along the line | β (rad/k m) |
| 83 | Distortion less line | - | A line in which there is no phase or frequency distortion and also it is correctly terminated is called as distortion less line. | - |
| 84 | Condition for distortion less line | - | LG = RC | - |
| 85 | Reflection coefficient | K | The ratio of the amplitudes of the reflected and incident voltage waves at the receiving end of the line is called the reflection coefficient. $K = (Z_R – Z_0) / (Z_R + Z_0)$ | - |
| 86 | Finite line | - | A finite line is a line having a finite length on the line. It is a line, which is terminated, in its characteristic impedance (ZR=Z0), so the input impedance of the finite line is equal to the characteristic impedance (Zs=Z0). | - |
| 87 | Infinite line | - | An infinite line is a line in which the length of the transmission line is infinite. A finite line, which is terminated in its characteristic impedance, is termed as infinite line. So for an infinite line, the input impedance is equivalent to the characteristic impedance. | - |
| 88 | Wavelength of a line | λ | The distance the wave travels along the line while the phase angle is changing through 2Π radians is called a wavelength. $\lambda = 2\Pi/\beta$ | m/s |
| 89 | Types of line distortions | - | The distortions occurring in the transmission line are called waveform distortion or line distortion. Waveform distortion is of two types: a) Frequency distortion b) Phase or Delay Distortion. | - |
| 90 | Frequency distortion | - | When a signal having many frequency components are transmitted along the line, all the frequencies will not have equal attenuation and hence the received end waveform will not be identical with the input | - |

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| | | | waveform at the sending end because each frequency is having different attenuation. This type of distortion is called frequency distortion. | |
| 91 | Avoid the frequency distortion | - | In order to reduce frequency distortion occurring in the line,<br>a) The attenuation constant α should be made independent of frequency.<br>b) By using equalizers at the line terminals which minimize the frequency distortion. | - |
| 92 | Delay distortion | - | When a signal having many frequency components are transmitted along the line, all the frequencies will not have same time of transmission, some frequencies being delayed more than others. So the received end waveform will not be identical with the input waveform at the sending end because some frequency components will be delayed more than those of other frequencies. This type of distortion is called phase or delay distortion. | - |
| 93 | Standing wave | - | When a line is not terminated correctly into its characteristic impedance, then a part of energy transmitted is return back to the source as reflected wave. Then, the distribution of voltage along the length of the line is not uniform, but minimum or maximum at different points. They appear to be standing at one point. These waves are called as standing wave. | - |
| 94 | Node and Antinode | - | The points of minimum and maximum voltage or current in a standing wave are called as node and antinode. | - |
| 95 | Standing Wave Ratio (SWR) | S | The ratio between maximum to minimum amplitude of voltage or current in a standing wave is called as standing wave ratio.<br>$S = \frac{E\ max}{E\ min}$ or $S = \frac{I\ max}{I\ min}$ | - |
| 96 | Range of SWR | - | Minimum value =1 (For load matched condition)<br>Maximum value = ∞ (For open or short circuit) | - |
| 97 | Relation between K and SWR | K and S | $S = (1 + \lvert K \rvert) / (1 - \lvert K \rvert)$<br><br>$K = (\lvert S \rvert - 1) / (\lvert S \rvert + 1)$ | - |
| 98 | Electrical length | - | The length of the transmission line expressed in terms of wavelength is called as electrical | - |

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| | | | length | |
| 99 | Smith chart | - | It is a valuable graphical tool for solving radio frequency transmission line problem.<br>It is used in the measurement of admittance, VSWR, reflection coefficient, impedance to admittance conversions and designing matching networks. | - |
| 100 | Impedance matching | - | To deliver maximum power to the load, impedance matching is done. The impedance matching technique matches the load impedance with the source or characteristic impedance. | - |
| | | **Unit-V : Plane Electromagnetic Waves** | | |
| 101 | Poynting vector | - | Vector product of electric field intensity and magnetic field intensity.<br>P=E x H | - |
| 102 | Plane wave | - | Phase of a wave is the same for all points on a plane surface | - |
| 103 | Uniform plane wave | - | The amplitude is constant in a plane wave | - |
| 104 | Intrinsic impedance (or) characteristic impedance | $\eta$ | $\eta = \sqrt{E/H} = \sqrt{\mu/\xi}$ | Ohm |
| 105 | Skin depth | $\delta$ | It is defined as that depth in which the wave has been attenuated to 1/e or approximately 37% of its original value.<br><br>$\delta = \sqrt{(1/\omega\mu\xi)}$ | meter |
| 106 | Wave guide | - | It is a hollow conducting metallic tube of uniform cross section used for propagating electromagnetic waves. | - |
| 107 | TE wave or H wave | - | Transverse electric (TE) wave is a wave in which the electric field strength E is entirely transverse. It has a magnetic field strength in the direction of propagation and no component of electric field in the direction of propagation. | - |
| 108 | TM wave or E wave | - | Transverse magnetic (TM) wave is a wave in which the magnetic field strength H is entirely transverse. It has electric field strength in the direction of propagation and no component of magnetic field in the direction of propagation. | - |
| 109 | TEM wave | - | The TEM waves are Transverse Electro Magnetic waves in which both electric and magnetic fields are transverse entirely but have no components in the direction of propagation. It is also referred to as the | - |

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| | | | principal wave. | |
| 110 | Parallel plane wave guide | - | Parallel plane wave guide consists of two conducting sheets separated by a dielectric material. | - |
| 111 | Quality factor | Q | The quality factor Q is a measure of frequency selectivity of the resonator.<br>It is defined as<br>Q = 2 π x Maximum energy stored / Energy dissipated per cycle | - |
| 112 | Free- space medium | - | Free-space medium is one in which there are no conduction currents and no charges. | - |
| 113 | Maxwell's equations | - | $\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$<br>$\nabla \cdot \mathbf{B} = 0$<br>$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$<br>$\nabla \times \mathbf{B} = \mu_0 \mathbf{J} + \mu_0 \varepsilon_0 \frac{\partial \mathbf{E}}{\partial t}$ | - |
| 114 | Phase velocity | Vp | Phase velocity is defined as the velocity of propagation of equiphasic surfaces along a guide.<br>Vp = ω / β | - |
| 115 | Group velocity | Vg | Group velocity (vg) is defined as the velocity with which the energy propagates along a guide.<br>Vg = dω / d β | - |
| 116 | Dominant mode | - | The modes that have the lowest cut off frequency is called the dominant mode. | - |
| 117 | Dominant mode for TE waves | - | Dominant mode: TE10 | - |
| 118 | Dominant mode for TM waves | - | Dominant mode: TM01 | - |
| 119 | Characteristics of TEM waves | - | It is a special type of TM wave<br>It doesn't have either e or H component<br>Its velocity is independent of frequency<br>Its cut-off frequency is zero. | - |
| 120 | Attenuation factor | - | Attenuation factor = (Power lost/ unit length)/(2 x power transmitted) | - |
| 121 | Wave impedance | - | Wave impedance is defined as the ratio of electric to magnetic field strength<br>Zxy= Ex/ Hy in the positive direction<br>Zxy= -Ex/ Hy in the negative direction | - |
| 122 | Parallel plane wave guide | - | Parallel plane wave guide consists of two conducting sheets separated by a dielectric material. | - |
| 123 | Applications of wave guides | - | The wave guides are employed for transmission of energy at very high | - |

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| | | | frequencies where the attenuation caused by wave guide is smaller.<br>Waveguides are used in microwave transmission. Circular waveguides are used as attenuators and phase shifters. | |
| 124 | Minimum attenuation of TM mode | - | The attenuation of αTM reaches a minimum value at a frequency equal to √3 times the cut off frequency.<br>$f=\sqrt{3}\, f_c$ | - |
| 125 | Relation Between Vp & Vg | - | Relation Between Vp & Vg is<br>Vp * Vg = C^2<br>Where C is free space velocity. | - |
| **Placement Questions** | | | | |
| 126 | Scalar Quantity | - | Characterized only by magnitude. Eg: mass, time, temperature & electric potential | - |
| 127 | Vector Quantity | - | Characterized by both magnitude and direction. Eg: force, velocity, electric field intensity & electric flux density. | - |
| 128 | Scalar multiplication | (.) | Dot product i.e., A^. B^ = AB Cosθ<br>It obeys commutative law i.e, A.B=B.A<br>If two vectors are said to be perpendicular to each other then its dot product is zero. | - |
| 129 | Vector Multiplication | (X) | Cross product i.e., A^X B^ = ABSinθ and<br>A^X B^= - B^X A^<br>If two vectors are said to be parallel to each other then its cross product is zero. | - |
| 130 | Solenoidal | - | A vector is said to be solenoidal if its divergence is zero. | - |
| 131 | Irrotational | - | A vector is said to be iirotational if its curl is zero. | - |
| 132 | Unit vector | - | $\hat{a}_r$ = vector r / magnitude of r | |
| 133 | Coordinate system | - | To describe a vector accurately and to express a vector in terms of its components, it is necessary to have some reference directions. | - |
| 134 | Coordinate system | - | To describe a vector accurately and to express a vector in terms of its components, it is necessary to have some reference directions. | - |
| 135 | Divergence theorem | - | Converts the surface integral into a volume integral, provided that the closed surface encloses certain volume.<br>$\iint_s \hat{F} . d\hat{s} = \iiint_v (\nabla . \hat{F})\, dv$ | - |
| 136 | Stokes theorem | - | Relates a line integral into a surface integral.<br>$\int_L \hat{F} . d\hat{L} = \iint_s (\nabla \times \hat{F})\, d\hat{s}$ | - |
| 137 | Coulombs law | - | The force of attraction (or) repulsion between any two point charges is directly proportional to the product of two charges and inversely | - |

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| | | | proportional to the square of the distance between them. $F = Q_1Q_2 / 4\pi\varepsilon r^2$ | |
| 138 | Electric field intensity | E | Electric force per unit charge<br>$E = F/q = Q / 4\pi\varepsilon r^2$ | Volts / Meter |
| 139 | Gauss law | - | Net flux passing through any closed surface is equal to the charge enclosed by that surface.<br>Integral form : $\int_s D\hat{}.ds\hat{} = Q$<br>Differential form : $\nabla.D = \rho_v$ | - |
| 140 | Electric Potential | V | Potential difference between two points:<br>$V = [(Q / 4\pi\varepsilon r_2) - (Q / 4\pi\varepsilon r_1)]$ | Volts |
| 141 | Relation between E and V | - | Electric field strength at any point is negative of the potential gradient at that point.<br>$E = -\nabla V$ | |
| 142 | Electric Flux Density | D | Total flux per unit surface area.<br>$D = [Q / 4\pi r^2]\,\hat{a}_r$ | Coulomb / Meter$^2$ |
| 143 | Poisson's equation | - | $\nabla^2 V = -[\rho_v / \varepsilon]$<br>charge enclosed by the region in terms of volume charge density is $\rho_v$ | - |
| 144 | Laplace's equation | - | $\nabla^2 V = 0$<br>Charge free region i.e., $\rho_v = 0$. | - |
| 145 | Magnetic Flux | $\phi$ | Flux passing through any area | weber |
| 146 | Magnetic Flux density | B | Magnetic flux density passing per unit area | Weber /m$^2$ |
| 147 | Biot - Savart's law | - | The magnetic field intensity $d\vec{H}$ at P can be written as<br>$dH = \frac{IdlSin\alpha}{4\pi R^2}$ | Ampere/m |
| 148 | Ampere's Circuital Law | - | The line integral of the magnetic field $\vec{H}$ around a closed path is the net current enclosed by this path.<br>$\oint \vec{H}.d\vec{l} = I_{enc}$ | - |
| 149 | Current density | J | Current per unit area | A/m$^2$ |
| 150 | Energy density | - | Energy per volume | Joule/ m$^3$ |

**Signatures**

**Faculty Team Prepared**

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