

D 114599

(Pages : 2)

Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)  
EXAMINATION, NOVEMBER 2024**

(CBCSS)

Physics

PHY IC 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

**Section A***8 Short questions answerable within 7.5 minutes**Answer **all** questions, each question carries weightage 1.*

1. Write down Faraday's law with amperes correction.
2. Define polarization current.
3. What is the significance of plasma frequency ?
4. Define plane of incidence.
5. Define reflection co-efficient and transmission co-efficient.
6. Define plasma parameter.
7. Define Transverse electro magnetic wave.
8. What is micro-strip lines ?

(8 × 1 = 8 weightage)

**Section B***4 essay questions answerable within 30 minutes.**Answer any **two** questions, each question carries weightage 5.*

9. Analyze the behaviour of transverse magnetic waves allow uniform guiding structures.
10. Write down Maxwell's equations in medium. Explain the relevance of the equations.
11. Explain the general transformation rules in electromagnetic fields to obtain rules of transformations.

**Turn over**

12. Explain group velocity, face velocity and derive the relation connecting them. Also write down the conditions for no dispersion, normal dispersion and anomalous dispersion.

(2 × 5 = 10 weightage)

### Section C

*7 problems answerable within 15 minutes.*

*Answer any **four** questions, each question carries weightage 3.*

13. Explain how a changing electric field induces a magnetic field
14. The permittivity of water at optical frequencies is  $1.75\epsilon_0$ . It is found that an isotropic light source at a distance  $d$  under water yields an illuminated circular area of a radius  $5\text{ m}$ . determine  $d$ .
15. The electric field intensity of a linearly polarized uniform plane wave propagating in the positive  $z$  direction is in seawater is  $E_x = 100 \cos(10^7 \pi t)$  (V/m) at  $Z = 0$ . The constitutive parameters of seawater are  $\epsilon_r = 72$ ,  $\mu_r = 1$  and  $\sigma = 4$  (S/m). Determine the attenuation constant, phase constant, intrinsic impedance, phase velocity, wavelength and skin depth (Problem).
16. Calculate Debye length of a collection of plasma at temperature  $1000\text{C}$  contains a density  $n = 4 \times 10^6 \text{ m}^{-3}$ .
17. Compute the density (unit  $\text{m}^{-3}$ ) of an ideal gas under the following conditions a)  $0^\circ\text{C}$  and  $760\text{ Torr}$  ( $1\text{ Torr} = 1\text{ mm of HG}$ ) pressure b) In vacuum at  $10^{-3}\text{ Torr}$  pressure and  $\text{Temp} = 20^\circ\text{C}$ .
18. Explain boundary conditions of electrodynamics.
19. What is field Tensor ? Explain.

(4 × 3 = 12 weightage)

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**FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)  
EXAMINATION, NOVEMBER 2023**

(CBCSS)

Physics

PHY IC 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

**Section A***8 short questions, each answerable within 7.5 minutes.**Answer **all** questions, each question carries 1 weightage.*

1. What is the intrinsic impedance of the free space ? Give the equation.
2. Define group velocity.
3. What is Poynting vector ?
4. Define total reflection, critical angle and the equation for critical angle.
5. Define a) Propagation constant ; b) Attenuation constant ; and c) Phase constant.
6. What is the constitution of ionosphere ?
7. What is Plasma ?
8. Define displacement current

(8 × 1 = 8 weightage)

**Section B***4 essay questions, each answerable within 30 minutes.**Answer any **two** questions, each question carries weightage 5.*

9. Explain polarization of a plain wave and derive the equation .Explain circularly polarized waves what is meant by negative circularly polarization.
10. Analyse the behaviour of transverse magnetic waves allow uniform guiding structures.

**Turn over**

11. Explain plasma fluid equations.
12. Explain Maxwell's equations. In detail, explain boundary conditions of electrodynamics.

(2 × 5 = 10 weightage)

### Section C

*7 problems answerable within 15 minutes.*

*Answer any **four** questions, each question carries weightage 3.*

13. Prove that a linearly polarized plain wave can be resolved into a right hand circularly polarized wave and left hand circularly polarized wave of equal amplitude
14. It has been estimated that the spacecraft reenters the Earth's atmosphere the surrounding atoms and molecules create plasma, electron density is in the neighborhood of  $2 \times 10^8$  per  $\text{cm}^3$ . Discuss the plasmas effect on frequency usage in radio communication between the spacecraft and the mission controllers on earth.
15. A uniform plane wave in a loss less medium with intrinsic impedancet  $\eta_1$  incident normally on to another lossless medium with intrinsic impedance  $\eta_2$  through a plane boundary. Obtain the expression for the time average power densities in both media.
16. Write a transmission line equations for a loss plus parallel plate line supporting TEM waves.
17. Derive the motion of plasma in time varying B field.
18. Compute  $\lambda_D$  and  $\lambda_D$  for the following cases :
  - a) A glow discharge with  $n = 10^{16} \text{ m}^{-3}$   $KTe = 2 \text{ eV}$
  - b) Earth's ionosphere with  $n = 10^{12} \text{ m}^{-3}$   $KTe = 0.1 \text{ eV}$
  - c) A  $\theta$  pinch with  $n = 10^{23} \text{ m}^{-3}$   $KTe = 800 \text{ eV}$
19. With figure explain Debye shielding

(4 × 3 = 12 weightage)

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Name.....

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**FIRST SEMESTER M.Sc. (CBCSS) REGULAR/SUPPLEMENTARY DEGREE  
EXAMINATION, NOVEMBER 2022**

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2019 Admission onwards)

Time : Three Hours

Maximum Weightage : 30

**Section A (Short Answers)**

*Answer All questions..Each question carries a weightage 1  
8 short questions answerable within 7.5 minutes*

1. Write down the integral forms of Maxwell's equations. What are its significance ?
2. Distinguish between group velocity and phase velocity.
3. Define standing wave ratio. How does it vary with reflection coefficient ?
4. Explain the characteristic impedance of a transmission line.
5. What are cavity resonators ?
6. Give the electromagnetic field tensor.
7. Explain the phenomenon of Debye shielding.
8. What are plasma oscillations ?

(8 × 1 = 8 weightage)

**Section B (Essays)**

*Answer any two questions..Each question carries a weightage 5  
4 essay questions answerable within 30 minutes.*

9. Derive the inhomogeneous wave equations for potentials A and V. Solve these equations to obtain the retarded scalar and vector potentials.
10. Obtain the instantaneous field expressions for TM modes in a rectangular waveguide of sides  $a$  and  $b$ .
11. Derive Maxwell's equations in relativistic form.
12. Derive the Vlasov equation in kinetic theory.

(2 × 5 = 10 weightage)

**Turn over**

**Section C**

*Answer any four questions..Each question carries a weightage 3  
7 problems answerable within 15 minutes..*

13. A sinusoidal electric intensity of amplitude 50 (V/m) and frequency 0.1 (GHz) exists in a lossy dielectric medium that has a relative permittivity of 2.25 and a loss tangent of 0.01. Find the average power dissipated in the medium per cubic meter ?
14. Derive an expression for instantaneous Poynting vector in the case of a time harmonic electromagnetic field.
15. A uniform plane wave ( $\mathbf{E} = z E_z$ ) is propagating through a lossless medium along  $+x$  direction. The field  $E_z$  is sinusoidal and has a maximum value of  $10^5$  V/m at  $t = 0$  and  $x = 0.2$  m. Obtain the instantaneous expressions for  $\mathbf{E}$  and  $\mathbf{H}$  ? Assume the frequency of the field as 120 MHz, and the medium is with  $(\epsilon_r = 3.6, \mu_r = 1, \sigma = 0)$ .
16. Prove that TEM waves cannot exist in a single-conductor hollow waveguide of any shape.
17. What is the electric field of a point charge  $q$  in a system  $S$  which moves with a speed  $v_0$  with respect to reference system  $S_0$  ? The point charge is assumed to be at rest in the system  $S_0$ .
18. Obtain an expression for convective derivative ? Explain its significances.
19. Compute the Larmor radius for a 8 keV electron in the earth's magnetic field of  $3.8 \times 10^{-5}$  Tesla. How does it vary for a proton streaming with velocity 300 km/s. ?

(4 × 3 = 12 weightage)

D 13159

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Name.....

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**FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)  
EXAMINATION, NOVEMBER 2021**

(CBCSS)

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

**General Instructions**

1. *In cases where choices are provided, students can attend **all** questions in each section.*
2. *The minimum number of questions to be attended from the Section / Part shall remain the same.*
3. *The instruction if any, to attend a minimum number of questions from each sub section / sub part / sub division may be ignored.*
4. *There will be an overall ceiling for each Section / Part that is equivalent to the maximum weightage of the Section / Part.*

**Section A***(8 Short questions answerable within 7.5 minutes)**Answer **all** questions.**Each carry weightage 1.*

1. Explain the loss tangent of a medium. How do we define a good conductor in a time varying field?
2. Define reflection coefficient and transmission coefficient. Obtain the relation between them.
3. Explain the term skin depth. How does it vary with wavelength?
4. State the boundary conditions to be satisfied by  $H_z$  for TE waves in a rectangular waveguide.
5. Define the quality factor of a cavity resonator.
6. Express the field tensor in terms of four-vector potential.
7. What is meant by plasma frequency? Give the expression.
8. Explain the Krook collision term.

 $(8 \times 1 = 8 \text{ weightage})$ **Turn over**

**Section B***(4 essay questions answerable within 30 minutes)**Answer any **two** questions.**Each carry weightage 5.*

9. Derive the homogeneous electromagnetic wave equations in a source free region ?
10. Obtain the general transmission-line equations for arbitrary time dependence and for time-harmonic time dependence ?
11. Derive the general transformation rules for electromagnetic field.
12. Derive the fluid equation of motion in isotropic case.

 $(2 \times 5 = 10 \text{ weightage})$ **Section C***(7 problems answerable within 15 minutes)**Answer any **four** questions.**Each carry weightage 3.*

13. Obtain the boundary conditions between a lossless dielectric and a perfect conductor.
14. Prove that a uniform plane wave propagating in an arbitrary direction  $\hat{a}$ , is a TEM wave with E perpendicular to H and that both E and H are normal to  $\hat{a}$ .
15. A narrow-band signal propagates in a lossy dielectric medium which has a loss tangent 0.12 at 500 kHz, the carrier frequency of the signal. The dielectric constant of the medium is 2. Calculate the phase and group velocity ?
16. A signal generator having an internal resistance  $1 \Omega$  and an open circuit voltage  $v(t) = 0.03\cos(2\pi(10^6)t)$  is connected to a  $48 \Omega$  lossless transmission line. If the velocity of wave propagation on the line is  $10^8$  (m/s), find the instantaneous expressions for the voltage and current at an arbitrary location on the line. Find the average power transmitted to the load ?
17. Derive the continuity equation in tensor form.
18. Compute the Larmor radius for a solar proton streaming with velocity 240 km/s in a magnetic field of  $(5 \times 10^{-5})$  Tesla ? What does its value for a 1.1keV He<sup>+</sup> ion in the same field ?
19. Compute  $\lambda_D$  and  $N_D$  in a fusion reactor with capacity of ion concentration from  $10^{13}/\text{m}^3$  to  $10^9/\text{m}^3$  and at  $kT_e$  0.01eV.

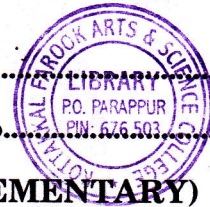
 $(4 \times 3 = 12 \text{ weightage})$

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Name.....

Reg. No.....



**FIRST SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)  
EXAMINATION, NOVEMBER 2020**

(CBCSS)

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2019 Admissions)

Time : Three Hours

Maximum : 30 Weightage

*General Instructions.***Section A***Eight short questions answerable within 7½ minutes.**Answer all questions.**Each question carries weightage 1.*

1. Explain the Lorentz gauge condition for potentials.
2. State and explain Poynting's theorem.
3. Explain Snell's law of refraction in the case of oblique incidence at a plane dielectric boundary.
4. What are evanescent waves ?
5. Write down the time-harmonic transmission-line equations for phasors  $V(z)$  and  $I(z)$ .
6. The magnetic field is zero in the particle's rest frame  $S_0$ . What is the value of magnetic field in a system  $S$ , moving with a speed  $v$  relative to  $S_0$  ?
7. Give the stress tensor for plasmas in the presence of magnetic field.
8. Outline the criteria for plasmas.

(8 × 1 = 8 weightage)

**Section B***Four essay questions answerable within 30 minutes.**Answer any two questions.**Each question carries weightage 5.*

9. Derive the time harmonic Helmholtz's equations for scalar potential  $V$  and vector potential  $A$ . What are its solutions ?
10. Obtain the instantaneous field expressions for TE modes in a rectangular waveguide of sides  $a$  and  $b$ .
11. Express the field tensor in terms of four vector potentials. Also, deduce the Maxwell's equation in potential form.
12. Derive the fluid equations of motion from the moments of Boltzmann equation.

(2 × 5 = 10 weightage)

**Turn over**

**Section C**

*Seven problems answerable within 15 minutes.*

*Answer any **four** questions.*

*Each question carries weightage 3.*

13. Express  $(4 \cos \omega t - 3 \sin \omega t)$  as first (a)  $A_1 \cos (\omega t + \theta_1)$ , and then (b)  $A_2 \sin (\omega t + \theta_2)$ . Determine  $A_1, A_2, \theta_1, \theta_2$ .
14. Derive the relation between group velocity and phase velocity. Also, detail the conditions of dispersion.
15. Assume that a uniform plane wave in a lossless medium with intrinsic impedance  $\eta$  is incident normally onto another medium with intrinsic impedance  $\xi$ , through a plane boundary. Evaluate the expression connecting reflection coefficient and transmission coefficient.
16. Find the size of a hollow cubic cavity made of copper in order to have a dominant resonant frequency of 9 GHz. Also evaluate the quality factor at that frequency. ( $\sigma = 5.8 \times 10^7 \text{ S/m}$ ).
17. Prove that the current density vector,  $\mathbf{J}^{\mu}$ , is divergenceless.
18. Compute  $\lambda_D$  and  $N_D$  in the earth's ionosphere with ion concentration  $10^{13}/\text{m}^3$  and  $kT_e$  from 0.1 eV to 0.01 eV.
19. Derive an expression for plasma frequency in the absence of magnetic field and thermal motion.  
(4 × 3 = 12 weightage)

**D 72793**

(Pages : 2)

Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2019**

(CUCSS)

Physics

**PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS**

(2012 Admissions)

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.*

*Each question carries a weightage of 1.*

1. What are harmonic fields ?
2. What are potential functions ?
3. What are plane waves ?
4. What is a lossless medium ?
5. Explain the term group velocity.
6. What are finite transmission lines ?
7. Explain the term "standing wave ratio".
8. What is a four vector ? Give the components of velocity four vector.
9. Explain Debye Shielding.
10. What is meant by plasma oscillations ?
11. What is a field tensor ?
12. Explain the significance of Alfvén waves.

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions.*

*Each question carries a weightage of 6.*

13. Write down the wave equations and obtain their solutions.
14. Discuss the oblique incidence of electromagnetic waves at a plane conducting boundary.

**Turn over**

15. Discuss the potential formulation of relativistic electrodynamics.
16. Derive the Boltzmann and Vlasov equations.

(2 × 6 = 12 weightage)

### Section C

*Answer any four questions.*

*Each question carries a weightage of 3.*

17. The scalar and vector potentials are given by  $\Phi = 0$  and  $\mathbf{A} = A_0 \sin(kx - \omega t) \hat{j}$ . Find  $\bar{\mathbf{E}}$  and  $\bar{\mathbf{B}}$  and show that  $\nabla \cdot \bar{\mathbf{E}} = 0$  and  $\nabla \cdot \bar{\mathbf{B}} = 0$ .
18. An electromagnetic wave is travelling in free space of permittivity  $\epsilon_0$  with electric field  $\bar{\mathbf{E}} = E_0 \cos(kx - ct)$ . Find the average power per unit area crossing planes parallel to  $4x + 3y = 0$ .
19. The magnetic field of the  $TE_{11}$  mode of a rectangular wave guide of dimensions  $3.33 \times 2.5 \text{ cm}^2$  is  $H_z = H_0 \cos(0.3\pi x) \cos(0.4\pi y)$ . Evaluate the cut off frequency for the wave guide.
20. Show that the tensor equation  $\frac{\partial G^{\mu\nu}}{\partial x^\nu} = 0$  represents  $\nabla \cdot \bar{\mathbf{B}} = 0$ .
21. A wave from free space strikes a lossless liquid surface ( $\epsilon_r = 80$ ) at an angle  $25^\circ$  from the normal. Estimate the angle of reflection and refraction.
22. Calculate the plasma frequency and maximum penetration depth for a plasma density of  $10^{18}$  electrons/m<sup>2</sup>.

(4 × 3 = 12 weightage)

13. Discuss the various characteristics of organizational culture.
14. What is work group ? Explain its importance.

(4 × 3 = 12 weightage)

### Section C

*Answer any two questions.*

*Each question carries a weightage of 5.*

15. Explain the ethical issues in organizational behaviour.
16. What are the steps involved in measuring organizational culture ?
17. What is meant by benchmarking ? Explain the process involved in it ?
18. Explain various techniques for managing organizational relationship.

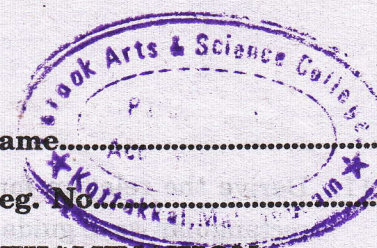
(2 × 5 = 10 weightage)

D 72980

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Name.....

Reg. No.....



**FIRST SEMESTER M.A./M.Sc./M.Com. DEGREE EXAMINATION  
DECEMBER 2019**

(CBCSS)

Physics

**PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS**

(2019 Admissions)

Time : Three Hours

Maximum : 30 Weightage

**Section A**

*Answer all questions.*

*Each question carries a weightage of 1.*

1. What was the inconsistency of Ampere's law ? How did Maxwell rectify it ?
2. Show that the vector and scalar potentials are not uniquely defined for a given electric and magnetic fields ?
3. Explain why excellent conductors make good mirrors ?
4. State and explain Poyning's theorem.
5. Show that the current density four vector has zero divergence ?
6. "The invariant interval between causally related events is always timelike". Explain ?
7. Derive the expression for cyclotron frequency.
8. Write a brief note on Vlasov equation.

(8 × 1 = 8 weightage)

**Section B**

*Answer any two questions.*

*Each question carries a weightage of 5.*

9. Derive the relation for the multipole expansion of electric scalar potential. Show that the electric field of a "pure" dipole can be written in the coordinate free form.
10. Derive the Fresnel's equation for reflection and transmission at oblique incidence for an electromagnetic wave falling on a dielectric interface when the polarization of the incoming wave is parallel to the plane of incidence. Obtain the relation for the Brewster's angle in this case.

**Turn over**

11. Derive the relation for the cutoff frequency for transverse electric wave passing through a rectangular wave guide. Explain why TEM waves do not occur in a hollow wave guide ?
12. Discuss the concept of Debye shielding and derive an expression for Debye length.

(2 × 5 = 10 weightage)

### Section C

*Answer any four questions.*

*Each question carries a weightage of 3.*

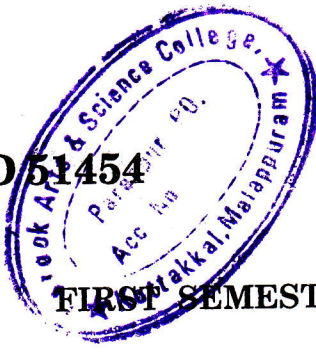
13. A thin glass rod of radius  $R$  and length  $L$  carries a uniform surface charge  $\sigma$ . It is set spinning about its axis at an angular velocity  $\omega$ . Find the magnetic field at a distance  $s \gg R$  from the center of the rod.
14. Calculate the power (energy per unit time) transported down the cables as shown in the following figure, assuming the two conductors are held at potential difference  $V$ , and carry current  $I$  with directions as indicated in the figure



15. Prove that a lossy transmission line is as dispersive as a lossy dielectric.
16. Show that the retarded potentials satisfy the Lorentz gauge condition.
17. Define four velocity . Show that is invariant under Lorentz transformation.
18. Express Maxwell's equations using electrodynamic field tensor and its dual tensor.
19. Given that Boltzmann constant  $k = 1.38 \times 10^{-23}$  J/K find the number density of an ideal gas at  $0^\circ\text{C}$  and atmospheric pressure  $P = 1.013 \times 10^5 \text{ Nm}^{-2}$ .

(4 × 3 = 12 weightage)

D 51454



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Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2018**

(CUCSS—PG)

Physics

**PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS**

[2017 Syllabus Year]

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.*

*Each question carries weightage 1.*

1. Explain the significance of displacement current.
2. Distinguish between a phasor and a vector ?
3. Explain the situation where the reflection and transmission co-efficients are real.
4. What is meant by the wave impedance of total field ?
5. Give the phase relationship between voltage and current waves in an infinitely long transmission line.
6. What is meant by the cut off frequency of a waveguide ?
7. Define a cavity resonator ?
8. Write down the expression for Minkowski force on a charge  $q$ .
9. Show that the current density 4 - vector is divergenceless.
10. Give the criteria for plasmas.
11. Explain the term 'Larmor radius' ?
12. Write down the Fokker-Planck equation under coulomb collision.

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions.*

*Each question carries weightage 6.*

13. Define Poynting's vector ? Obtain the expressions for instantaneous and average power densities for time harmonic electromagnetic waves.
14. Derive the transmission line equations for a lossless parallel plate line supporting TEM waves ? Explain why waves along a lossy transmission line cannot be purely TEM.

**Turn over**

15. Derive Maxwell's equations in relativistic notation.
16. Obtain the fluid equations of motion for plasma. Give the significance of stress tensor.

(2 × 6 = 12 weightage)

### Section C

*Answer any four questions.*

*Each question carries weightage 3.*

17. Find the potential inside and outside of a uniformly charged spherical shell of radius  $R$  ?
18. A parallel plate capacitor of capacitance  $20 \mu\text{F}$  is connected across an AC voltage source,  $v = 5 \sin \pi t$ . Determine (i) the displacement current in the capacitor, and (ii) the intensity of magnetic field at a distance 5 cm from the wire, in terms of time 't' ?
19. A 5GHz, x - polarised uniform plane wave propagates in the +y direction in a nonmagnetic medium having a dielectric constant 1.5 and a loss tangent 0.001. Determine the intrinsic impedance, wavelength, phase velocity and group velocity of the wave in the medium ?
20. A transmission line of characteristic impedance,  $R_0 = 75 \Omega$ , is to be matched to a load impedance,  $Z_L = 50 + j, 10 \Omega$ , through a length  $l$  of another transmission line of characteristic impedance  $R_0$ . Determine the values of  $l$  and  $R_0$  for matching ?
21. A straight wire along x-axis carries a charge density  $\lambda$  travelling in the +x direction at speed  $v$ . Construct the field tensor and the dual tensor at the point  $(y, 0, 0)$ .
22. (a) A distant galaxy contains a cloud of protons and antiprotons, each with density  $10^{11} /\text{m}^3$  and temperature 100K. Determine the Debye length and the number of particles in a Debye sphere ?  
(b) Find the cyclotron frequency of electrons in a perpendicular magnetic field of strength  $3 \times 10^{-4} \text{T}$  ?

(4 × 3 = 12 weightage)

**D 51450**



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Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, NOVEMBER 2018**

(CUCSS-PG)

Physics

**PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS**

[2012 Syllabus Year]

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.*

*Each question carries a weightage of 1.*

1. What are boundary conditions ?
2. What is the significance of wave equation ?
3. What is a plane wave ?
4. What is a lossy medium ?
5. Explain Poynting vector.
6. What is a cavity resonator ?
7. Explain the term Plasma.
8. What is meant by a polarizing angle ?
9. Give the advantage of representing electrodynamics in tensor notation.
10. State the expression between dielectric constant and Alfven velocity.
11. Explain the term Skin depth.
12. Explain the significance of Alfven waves.

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions.*

*Each question carries a weightage of 6.*

13. (a) Derive the wave equation for the electric field in vacuum.  
(b) Show that the plane electromagnetic waves follow laws of reflection.
14. Establish Maxwell's equations for the propagation of electromagnetic waves in a conducting medium at normal incidence.

**Turn over**

15. Discuss the wave characteristics on finite transmission lines.
16. Establish the potential formulation of relativistic electrodynamics.

(2 × 6 = 12 weightage)

### Section C

Answer any four questions.

Each question carries a weightage of 3.

17. Show that the fields  $\vec{E} = A_0 \omega \cos(kx - \omega t) \hat{j}$  and  $\vec{B} = A_0 k \cos(kx - \omega t) \hat{k}$  satisfy Maxwell's curl equations.
18. Obtain the current density  $\hat{j}$  corresponding to the magnetic vector potential  $\vec{A} = (-y^2 \hat{i} + x^2 \hat{j})$ .
19. The electric field associated with an electromagnetic wave is given by  $\vec{E} = 20 \sin(\omega t - kz) \hat{j} \left(\frac{V}{m}\right)$ .  
Find the corresponding magnetic field H (A/m).
20. The electric field of an electromagnetic wave is  $\vec{E} = \hat{i} E_0 \cos(kz - \omega t) + \hat{j} E_0 \sin(kz - \omega t)$ . Obtain the direction and the magnitude of Poynting vector.
21. A rectangular waveguide with dimensions  $2.28 \times 1.01 \text{ cm}^2$  is given. What TE mode will propagate in this wave guide, if the driving frequency is  $1.70 \times 10^{10} \text{ Hz}$ ?
22. Evaluate  $\lambda_D$  and  $N_D$  for the earth ionosphere with  $n = 10^6 \text{ cm}^{-3}$  and  $kT_e = 0.1 \text{ eV}$ .

(4 × 3 = 12 weightage)

13195

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Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2016**

(CUCSS)

Physics

**PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS**

(2012 Admissions)

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.*

*Each question carries a weightage of 1.*

1. Distinguish between Coulomb field and Faraday field.
2. What are transmission lines ?
3. Explain the term group velocity.
4. What is meant by a lossless medium ?
5. Compare and contrast the working of wave guides and transmission lines.
6. Explain cavity resonators.
7. Explain electromagnetic potentials.
8. What are four vectors ?
9. Briefly explain electric field due to a point charge.
10. What is Brewster angle ?
11. Explain the significance of Alfvén waves.
12. Explain the term Debye shielding.

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions.*

*Each question carries a weightage of 6.*

13. Prove that the plane electromagnetic waves follow the laws of reflection.
14. Derive the expression for the Poynting vector and comment on the results.
15. Obtain the Maxwell's equations in tensor notation.
16. What are plasma oscillations ? Derive a relation for the frequency of plasma oscillations starting from the appropriate fluid equation.

(2 × 6 = 12 weightage)

**Turn over**

## Section C

Answer any four questions.  
Each question carries a weightage of 3.

17. Show that the expression  $\vec{A} \left( \frac{B_0}{2} x, \frac{B_0}{2} y, 0 \right)$  does not represent a uniform magnetic field of magnitude  $B_0$  along the  $z$ -direction.
18. In free space  $E(z, t) = 50 \cos(\omega t - \beta z) \hat{i}$  (V/m). Find the average power crossing a circular area of radius 2 m in the plane  $z = \text{constant}$ .
19. A rectangular waveguide with dimensions 2 cm  $\times$  1 cm is given. What are the TE modes that occur in this waveguide, if the driving frequency is  $1.6 \times 10^{10}$  Hz.
20. Show that  $E^2 - B^2$  is Lorentz scalar.
21. A magnetic field  $\vec{B} = (\hat{i} + 2\hat{j} - 4\hat{k})$  exists in a certain region of space. If a test charge moving with a velocity  $\vec{v} = v_0 (3\hat{i} - \hat{j} + 2\hat{k})$  experiences no force at a certain point, then find the electric field at that point.
22. Calculate the plasma frequency and maximum penetration depth for a plasma density of  $10^{25}$  electrons/m<sup>3</sup>.

(4  $\times$  3 = 12 weightage)

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(Pages : 2)

Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, JANUARY 2014**

(CUCSS)

Physics

**PHY IC 03—ELECTRODYNAMIC AND PLASMA PHYSICS**

(2012 Admissions)

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.*

*Each question carries 1 weightage.*

1. Discuss the transmission of e.m. wave at normal incidence on a conducting interface.
2. What is skin depth ? Write down an expression for the same and explain.
3. Express electromagnetic potential in terms of Lorentz force.
4. Write down Maxwells equation in integral forms and explain their physical meaning.
5. Outline the principle operation of rectangular wave guides.
6. Explain, why magnetic vector lags behind the electric vector when e.m. waves propagate in a conducting medium.
7. Explain the kinematic properties of reflection and refraction of e.m. wave.
8. What are cavity resonators ? Explain.
9. Write down the Lorentz transformation matrix and give its importance.
10. Write down the expression for electric and magnetic field interms of scales and vector potential and give its importance.
11. Discuss the motion of charged particle in an electromagnetic field.
12. Discuss the use of Vlasov equation.

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions.*

*Each question carries 6 weightage.*

13. Establish the law of conservation of energy for the electromagnetic field. Explaining the meaning of various terms involved in it.

**Turn over**

14. Discuss with necessary theory the reflection and transmission of e.m. wave at oblique incidence. List and explain the conclusions.
15. Differentiate between the concepts of group velocity and phase velocity as applied to wave guides. Derive the universal formula for the group velocity.
16. Explain in detail the merits and application of potential formulation of relativistic electrodynamics.

(2 × 6 = 12 weightage)

### Section C

*Answer any four questions.*

*Each question carries 3 weightage.*

17. Show that the potentials at the position defined by the vector 'r' in uniform electric and magnetic field may be written as  $\phi = -E \cdot r$  and  $A = \frac{1}{2}(B \times r)$ .
18. Construct a tensor out of D and H, and use it to express Maxwell's equations inside matter in terms of current density  $J^{\mu}_{f \text{ sec}}$ .
19. A plane wave travelling in a homogeneous isotropic dielectric is incident obliquely at the plane surface of another dielectric. Determine the reflection coefficient.
20. For a lossless transmission line, the capacitance per unit length is 'C' and characteristic impedance is  $Z_0$ . Find the velocity of e.m. wave in the line.
21. Prove that change of frame of reference does not change the orthogonal property of E and B in e.m. wave.
22. Calculate  $\lambda_D$  and  $N_n$  for the earth Ionosphere with  $n = 10^6 \text{ cm}^{-3}$ ,  $kT_e = 0.1 \text{ eV}$ .

(4 × 3 = 12 marks)

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(Pages : 2)

Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2014**

(CUCSS)

Physics

**PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS**

(2012 admission onwards)

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.  
Each carries 1 weightage.*

1. Explain polarization of e.m. waves.
2. Show that the e.m. wave propagate in a dielectric medium with a velocity  $V = \frac{1}{\sqrt{\mu \epsilon}}$ .
3. Explain, why the definition of poynting vector is not a mandatory one.
4. What is Maxwell stress tensor ?
5. Write down Maxwell's equation in differential form and give their physical meaning.
6. How are the scalar and vector potential related to the electric and magnetic field ?
7. Explain how do cavity resonators resemble with electronic resonant circuits.
8. Discuss the phenomenon of radiation from an oscillating dipole.
9. With suitable example, explain symmetric tensor and antisymmetric tensor.
10. Prove that continuity equation follow from Maxwell's equation.
11. For an Alfvén wave show that time averaged ion kinetic energy/cm<sup>3</sup> is equal to the magnetic wave energy.
12. What is Debye shielding ? Give its significance.

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions.  
Each carries 6 weightage.*

13. Deduce Maxwell's equation of electromagnetic field and discuss it. Comment on the correspondence of the field B and H with E and D.
14. Discuss the reflection and transmission of e.m. wave at normal incidence at dielectric interface. Explain the relation connecting reflection coefficient and transmission coefficient.

**Turn over**

15. What are the difference, in the propagation and general behaviour, between TE and TM modes in rectangular waveguides ? Describe briefly the various methods of exciting waveguides.
16. With suitable example, explain the advantages of electrodynamics in tensor notation, and formulate Maxwell's equations in terms of tensors.

(2 × 6 = 12 weightage)

### Section C

*Answer any four questions.*

*Each carries 3 weightage.*

17. Show that for a plane electromagnetic wave poynting vector is 'C' times energy density of the field.
18. A straight wire along z-axis carries a charge density  $\lambda$  travelling in the + Z direction at speed V. Construct the field tensor and dual tensor at the point (x, 0).
19. Assuming that the electric vector of an e.m. wave is  $E = E \cdot e^{-1}(wt - kr)$ , Prove the various laws of reflection and refraction.
20. Prove that for glass-air interface ( $n_2 = 1.5$  and  $n_1 = 1.0$ ) for normal incidence of e.m. wave the reflection and transmission coefficients are 0.04 and 0.96 respectively.
21. If a charge  $q$  is at the origin of a system S, calculate the electric fields as observed by an observer in another frame S' at the instant the two origins coincide if S' is moving with uniform velocity 'v' along z-axis.
22. Prove that for a plasma wave  $V_p V_g = C^2$ , when the letters have usual meaning.

(4 × 3 = 12 weightage)

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Name.....

Reg. No.....

**FIRST SEMESTER M.Sc. DEGREE EXAMINATION, DECEMBER 2017**

(CUCSS)

Physics

PHY 1C 03—ELECTRODYNAMICS AND PLASMA PHYSICS

(2012 Admissions)

Time : Three Hours

Maximum : 36 Weightage

**Section A**

*Answer all questions.*

*Each question carries a weightage of 1.*

1. What are harmonic fields ?
2. Explain potential functions.
3. Explain skin depth.
4. What are loss less media ?
5. Give the boundary conditions for  $\bar{D}$  and  $\bar{B}$ .
6. What is a rectangular waveguide ?
7. Explain transmission lines.
8. Discuss the magnetic field due to a moving point charge.
9. Explain Debye shielding.
10. What are Vlasov equations ?
11. What are polar and nonpolar dielectrics ?
12. Define four vectors.

(12 × 1 = 12 weightage)

**Section B**

*Answer any two questions.*

*Each question carries a weightage of 6.*

13. What are Maxwell's dynamic equations. Arrive at the electromagnetic boundary conditions.
14. Discuss the oblique incidence of electromagnetic wave at a plane dielectric boundary.

**Turn over**

15. Discuss the electrodynamics in tensor notation.
16. Describe the theoretical treatment of motion of charged particle in an electromagnetic field.

(2 × 6 = 12 weightage)

### Section C

*Answer any four questions.*

*Each carries a weightage of 3.*

17. A wave from free space strikes a lossless water surface ( $\epsilon_r = 80$ ) at an angle of  $30^\circ$  from the normal. Evaluate the angle of reflection and refraction.
18. Energy from a 2000 Watt lamp is radiated uniformly. Evaluate the average intensities of electric and magnetic field of radiation at a distance 4 m from the lamp.
19. Calculate the plasma frequency and maximum penetration depth for a plasma density of  $10^{20}$  electrons/m<sup>3</sup>.
20. A rectangular waveguide has breadth 20 cm. Find the wavelength for a signal frequency of 3 GHz for the dominant mode
21. Prove that  $E^2 - c^2 B^2$  is a Lorentz scalar
22. Show that for a charged particle moving with velocity  $\vec{v}$ , the magnetic potential is given by

$$\vec{A} = \frac{\vec{v}}{c^2} V, \text{ where } V \text{ is the electrostatic potential.}$$

(4 × 3 = 12 weightage)