



WEST BENGAL STATE UNIVERSITY
B.Sc. Honours/Programme 2nd Semester Examination, 2023

PHSHGEC02T/PHSGCOR02T-PHYSICS (GE2/DSC2)

Time Allotted: 2 Hours

Full Marks: 40

*The figures in the margin indicate full marks.
Candidates should answer in their own words and adhere to the word limit as practicable.
All symbols are of usual significance.*

1. Answer any **ten** questions from the following: 2×10 = 20
নিম্নলিখিত যে-কোনো দশটি প্রশ্নের উত্তর দাওঃ
- (a) For a uniform electric field $\vec{E} = 4\hat{i} + 3\hat{j} + 8\hat{k}$, calculate the electric flux through a surface area of 10 square units lying in x - y plane.
কোন অঞ্চলে তড়িৎক্ষেত্রের প্রাবল্য $\vec{E} = 4\hat{i} + 3\hat{j} + 8\hat{k}$ হলে, x - y তলে অবস্থিত 10 বর্গএকক ক্ষেত্রের মধ্যে দিয়ে মোট কত ফ্লাক্স গমন করবে ?
- (b) What is differential form of Gauss' Law?
গাউসের উপপাদ্যের অবকলন সমীকরণটি লেখো।
- (c) Show that $\vec{A} = (4xy - z^3)\hat{i} + 2x^2\hat{j} - 3xz^2\hat{k}$ is an irrotational vector.
প্রমাণ করো, $\vec{A} = (4xy - z^3)\hat{i} + 2x^2\hat{j} - 3xz^2\hat{k}$ একটি অঘূর্ণ ভেক্টর।
- (d) What is the unit and dimension of capacity of a capacitor?
ধারকের ধারকত্বের একক এবং মাত্রা কি ?
- (e) Why is a series LCR circuit called "acceptor circuit"?
কেন LCR শ্রেণী সমবায়কে "অনুমোদক বর্তনী" বলা হয় ?
- (f) Show that electric field is conservative field.
দেখাও যে, তড়িৎক্ষেত্র হল সংরক্ষী ক্ষেত্র।
- (g) If vector \vec{A} has constant magnitude, show that $\vec{A} \cdot \frac{d\vec{A}}{dt} = 0$.
যদি \vec{A} ভেক্টরের মান ধ্রুবক হয়, তবে দেখাও যে, $\vec{A} \cdot \frac{d\vec{A}}{dt} = 0$ ।
- (h) State Biot-Savart's law.
বায়ো-সাবার্টের সূত্রটি লেখো।
- (i) Define the co-efficient of self-inductance of a coil. What is its SI unit?
একটি কুণ্ডলির স্বাবেশাঙ্ক বলতে কি বোঝায় ? এর SI একক কি ?
- (j) Explain the physical significance of curl of a vector.
ভেক্টরের 'কার্ল'-এর ভৌত তাৎপর্য ব্যাখ্যা করো।

(k) State Norton's theorem.

নর্টনের উপপাদ্যটি বিবৃত করো।

(l) What is the meaning of hysteresis in ferromagnetics?

অয়স্টেটিক পদার্থের হিস্টেরেসিস বলতে কি বোঝায় ?

(m) What is Faraday's Law?

ফ্যারাডের সূত্রটি লেখো।

(n) What is an electric dipole?

তড়িৎ দ্বিমেরু কাকে বলে ?

(o) A parallel plate air capacitor has plate area 0.2 m^2 and has separation distance 5.5 mm . Find its capacitance.

একটি সমান্তরাল পাত ধারকে পাতের ক্ষেত্রফল 0.2 m^2 এবং মধ্যবর্তী দূরত্ব 5.5 mm । এর ধারকত্ব নির্ণয় করো।

Answer any two from the following

$10 \times 2 = 20$

নিম্নলিখিত যে-কোনো দুটি প্রশ্নের উত্তর দাও

2. (a) Define divergence of a vector. Write down the expression for divergence in Cartesian co-ordinates system. Find the value of $\vec{\nabla} \cdot (r^n \vec{r})$.

$2+1+4$

ভেক্টররাশির ডাইভারজেন্সের সংজ্ঞা দাও। কার্টেসীয় নির্দেশতন্ত্রে ডাইভারজেন্সের রূপটি লেখো। $\vec{\nabla} \cdot (r^n \vec{r})$ -এর মান নির্ণয় করো।

(b) Find the unit vector perpendicular to $\vec{A} = 4\hat{i} - \hat{j} + 3\hat{k}$ and $\vec{B} = -2\hat{i} + \hat{j} - 2\hat{k}$.

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$\vec{A} = 4\hat{i} - \hat{j} + 3\hat{k}$ এবং $\vec{B} = -2\hat{i} + \hat{j} - 2\hat{k}$ ভেক্টরদ্বয়ের উপর লম্ব একক ভেক্টর নির্ণয় করো।

3. (a) Give the definition of polarization of a dielectric. Show how it is related to electric displacement vector?

$2+3$

পরাবিদ্যুতের মেরুবর্তিতা বলতে কি বোঝায় ? দেখাও কিভাবে এটি বৈদ্যুতিক ভ্রংশ (ডিসপ্লেসমেন্ট) ভেক্টরের সাথে যুক্ত ?

(b) Using Ampere's circuital law find the magnetic field due to a solenoid of length L and total turns N and the current through it is I .

3

অ্যাম্পিয়ারের বন্ধপথ সূত্রটি ব্যবহার করে L দৈর্ঘ্য এবং N পাকবিশিষ্ট সলিনয়েডের মধ্য দিয়ে I প্রবাহমাত্রার জন্য চৌম্বক ক্ষেত্রের মান নির্ণয় করো।

(c) If $\phi(x, y, z) = xy^2 + yz^3$ be a scalar function, find the component of $\vec{\nabla} \phi$ in the direction of the vector $\hat{i} - 2\hat{j} + 2\hat{k}$ at the point $(2, -1, 1)$.

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$\phi(x, y, z) = xy^2 + yz^3$ স্কেলার রাশি হলে $\vec{\nabla} \phi$ -এর $\hat{i} - 2\hat{j} + 2\hat{k}$ ভেক্টর বরাবর $(2, -1, 1)$ বিন্দুতে উপাংশ নির্ণয় করো।

4. (a) Write down the physical significances of Maxwell's equations. What is displacement current density?

$2+2$

ম্যাক্সওয়েলের সমীকরণগুলির ভৌত তাৎপর্য ব্যাখ্যা করো। সরণপ্রবাহ বলতে কি বোঝো ?

(b) Define magnetic susceptibility. 1

চৌম্বক প্রবণতার সংজ্ঞা দাও।

(c) How does ferromagnetic, paramagnetic and diamagnetic material respond when they are placed in an external magnetic field, explain. 2

অয়শ্চৌম্বক, তিরশ্চৌম্বক ও পরাচৌম্বক পদার্থকে বাহ্যিক চৌম্বকক্ষেত্রের মধ্যে রাখলে, কে কেমন আচরণ করবে ব্যাখ্যা করো।

(d) Find an expression for magnetic field at the centre of a circular ring with current I through it. 3

একটি বৃত্তীয় বলয়ের কেন্দ্রবিন্দুতে, I প্রবাহমাত্রার জন্য চৌম্বকক্ষেত্রের রাশিমালা নির্ণয় করো।

5. (a) In an AC circuit with L, C, R in series, show that the current in the circuit will be maximum when the frequency ω of the ac source is $\omega = \frac{1}{\sqrt{LC}}$. 6

শ্রেণী সমবায়ে যুক্ত L, C, R পরিবর্তী প্রবাহ বর্তনীর ac তড়িৎপ্রবাহের কম্পাঙ্ক ω হলে প্রমাণ করো যে বর্তনীতে প্রবাহমাত্রা সর্বোচ্চ হয় যদি $\omega = \frac{1}{\sqrt{LC}}$ হয়?

(b) The secondary and primary coils of a transformer have co-efficient of self inductance L_1 and L_2 respectively. If M be their co-efficient of mutual inductance then show that $M = \sqrt{L_1 L_2}$. 4

একটি রূপান্তরকের মুখ্য ও গৌণ কুণ্ডলির স্বাবেশ গুণাঙ্ক যথাক্রমে L_1 ও L_2 । তাদের পারস্পরিক আবেশ গুণাঙ্ক M হলে প্রমাণ করো $M = \sqrt{L_1 L_2}$ ।

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WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 2nd Semester Examination, 2023

PHSACOR04T-PHYSICS (CC4)

Time Allotted: 2 Hours

Full Marks: 40

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All symbols are of usual significance.*

Question No. 1 is compulsory and answer any two from the rest

1. Answer any *ten* questions from the following: 2×10 = 20
- What do you mean by 'resolving power' of an optical instrument?
 - What are the differences between Fresnel diffraction and Fraunhofer diffraction?
 - In Michelson interferometer 1000 fringes cross the field of view when the movable mirror is displaced through 0.293 mm. Calculate the wavelength of light?
 - Why is it necessary to use narrow source for biprism and extended source for Newton's ring?
 - State two dissimilarities between the vibrations of a plucked string and of a struck string.
 - What is the radius of the first half period zone in a zone plate behaving like a convex lens of focal length 60 cm for light of wavelength 6000 Å?
 - What do you mean by overlapping spectra in a diffraction grating pattern?
 - The tunnel leading through a hill greatly amplifies tones at 135 Hz and 138 Hz. Find the shortest length of the tunnel if velocity of sound in air is 330 m/s.
 - Define the term pseudoscopic image in holography.
 - What do you mean by acoustic pressure? Write relation between intensity and r.m.s. value of acoustic pressure of sound.
 - Write the assumptions which are useful to derive the expression for the velocity of plane progressive wave in fluid.
 - Find the missing orders of a double slit Fraunhofer diffraction pattern if the slit widths are 0.1 mm and they are 0.8 mm apart.
 - Young modulus of copper is 12.2×10^{10} N/m² and density of it 8900 kg/m³. Calculate speed of sound travelling through copper rod.
 - Explain why the quality of sound is richer in an open organ pipe than closed organ pipe.

2. (a) Explain the terms: (i) wavefront and (ii) wave velocity. 3
- (b) A soap film 5×10^{-5} cm thick is viewed at an angle of 35° to the normal. Find the wavelengths of light in the visible spectrum which will be absent from the reflected light. ($\mu = 1.33$) 3
- (c) With the help of suitable diagram describe the basic principle on which a Fabry-Perot interferometer works. 4
3. (a) Apply Huygen's principle of wave propagation to prove laws of reflection for a plane surface. 3
- (b) Show that the velocity of transverse waves along a stretched string is given by $c = \sqrt{T/m}$ where T is the tension and m is the mass per unit length. 3
- (c) Consider the one dimension wave equation $\frac{\partial^2 \psi}{\partial t^2} = c^2 \frac{\partial^2 \psi}{\partial x^2}$. Find the travelling wave solution satisfying the initial condition $\psi(x, 0) = g(x)$ and $\dot{\psi}(x, 0) = 0$. 4
4. (a) Define group velocity and phase velocity. Deduce the relation $v = c - \lambda \frac{dc}{d\lambda}$, where v is the group velocity and c is the phase velocity. In which type of medium will the two velocities be equal? 2+3+1
- (b) Explain how Laplace corrected the Newton's formula for velocity of sound in a gaseous medium. 2
- (c) At what temperature would the speed of sound in air be double its value at 0°C ? 2
5. (a) Derive the resultant motion when two SHMs with same frequency, but with different amplitudes, at right angles to each other are superposed. Draw the resultant trajectory when the phase difference between them is π . 4+1
- (b) Two vibrations along the same line are described by equations $x_1 = 0.03 \cos 10\pi t$, $x_2 = 0.03 \cos 12\pi t$, where x_1 and x_2 are measured in meters and t in seconds. Obtain the equation describing the resultant motion and hence find the beat period. 3
- (c) For single slit diffraction, show that the intensity of the central maximum is nearly 61 times of the 2nd maximum. 2

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WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 2nd Semester Examination, 2023

PHSACOR03T-PHYSICS (CC3)

Time Allotted: 2 Hours

Full Marks: 40

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All symbols are of usual significance.*

Answer Question No. 1 and any two questions from the rest

1. Answer any *ten* questions from the following: 2×10 = 20
- (a) Consider a line charge of infinite extent along the z -axis with a line charge density $\lambda(z) = \lambda_0/(1+z^2)$, λ_0 being a constant. Find the total charge.
 - (b) Draw the curve for electric potential inside and outside of a charged solid spherical conductor having a radius a_0 .
 - (c) An electrical charge distribution is given by $2q$ at $(0, a, a)$, q at $(0, -a, a)$ and $-q$ at $(0, 0, -a)$. Calculate the electric dipole moment of the charge distribution in vector form.
 - (d) Verify that the vector potential \vec{A} due to a uniform magnetic induction \vec{B} is given by $\vec{A} = -\frac{1}{2}(\vec{r} \times \vec{B})$.
 - (e) Three equal point charges $+q$ are located at the vertices of an equilateral triangle of sides a . What charge must be placed at the centroid to make the total electrostatic energy zero?
 - (f) Draw the phasor diagram of a series R-L-C resonance circuit.
 - (g) Why magnetic force acting on a charged particle is a no-work force?
 - (h) The magnetic intensity in a certain material having permeability $\mu = 5\mu_0$ is given by $\vec{H} = 2\hat{i} + 5\hat{j} - 8\hat{k}$. Calculate the susceptibility of the material and magnetization \vec{M} .
 - (i) In an oscillator circuit, $L = 0.1$ H, $C = 0.047$ μ F. Find the maximum value of resistance so that the circuit may oscillate.
 - (j) Find the voltage induced across a coil of 500 mH, if the rate of change of current through the coil is 2A/sec.
 - (k) Show that the Kirchoff's voltage law is consistent with the principle of conservation of energy.
 - (l) An ac series circuit has a resistance of 10 Ω , an inductance of 0.2 H and a capacitance of 60 μ F. Calculate the impedance of the circuit at resonance.
 - (m) Explain the fact that electric field inside a conductor is zero.
 - (n) Express Gauss's theorem in differential form.
2. (a) Determine the Coulomb's law of electrostatics from Gauss's theorem. 3
- (b) An infinite number of charges, each equal to q are placed along the z -axis at $z_1 = d$, $z_2 = 2d$, $z_3 = 4d$ and $z_4 = 8d$, and so on. Find the electric field at a point z due to this set of charges. 3

(c) A dipole with moment \vec{p} is fixed at the origin of a coordinate system and another with moment \vec{p}' is at the position vector \vec{r} and is able to rotate about its centre. Show that for equilibrium $\tan\theta = 2\tan\theta'$ where θ and θ' are the angles that \vec{r} makes with the first and second dipole respectively. 4

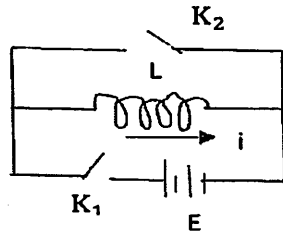
3. (a) Draw the hysteresis curve for a magnetic material and calculate the energy loss of that hysteresis loop. 1+2

(b) Derive the force between two parallel and identical circular turns of wire carrying currents I_1 and I_2 separated by a small distance 'd'. 3

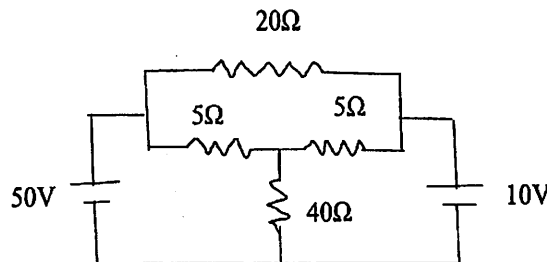
(c) In a region of space near the point $(-3m, 2m, 5m)$ the potential is $\phi = 30x^2 + 40y^2 - 10z^2$ volt. Find the value of total intensity of the electric field. 4

4. (a) Find the capacity of the condenser which is to be introduced in series with a 100 volt 50 watt lamp, to light it from 200 volt (r.m.s.) 50 Hz mains. 3

(b) In the following circuit, the switch K_2 is open and the switch K_1 is closed at time $t = 0$. At time $t = t_0$, the switch K_1 is open and the switch K_2 is simultaneously closed. Sketch the variation of the inductor current as a function of time. 3



(c) Using the superposition theorem, find the current through the $40\ \Omega$ resistor in the circuit given below 4



5. (a) A parallel combination of an ideal inductor and an ideal capacitor (L and C respectively) is connected in series with a resistance R and the circuit is then supplied with a sinusoidal voltage $v = V_0 \sin \omega t$. Show that the voltage across the LC-combination attains a maximum value when $\omega = \frac{1}{\sqrt{LC}}$. Also calculate the frequencies at which this voltage reduces to $1/\sqrt{2}$ of its maximum value. 2+2

(b) A conducting loop of resistance $4\ \Omega$ is in the plane of the paper. It has a uniform induction B over its area $0.002\ \text{m}^2$. The direction of \vec{B} is normal to the plane of the loop. Calculate the induced current in the loop if \vec{B} is decreasing at the rate of $0.1\ \text{wb/m}^2\text{s}$. 4

(c) Show that if a battery of fixed emf E and internal resistance r is connected to a variable external resistance R , the maximum power would be delivered to the external resistor when $R = r$. 2

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