



WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 4th Semester Examination, 2023

PHSACOR08T-PHYSICS (CC8)

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.*

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

1. Answer any *ten* questions from the following: 2×10 = 20
- (a) Solve $z^2(1-z^2)=16$, where z is a complex number.
- (b) Find the cube roots of $(-1+i)$.
- (c) Expand $f(z) = \ln(1+z)$ in a Taylor Series about $z=0$.
- (d) Find the three dimensional Fourier transform of three dimensional Dirac-delta function.
- (e) For a cylindrically symmetric potential ϕ , find the solution of one dimensional Laplace's equation.
- (f) Show that the product of two symmetric matrices is symmetric if they commute.
- (g) Evaluate e^A where matrix A is given by $A = \begin{bmatrix} 1 & 0 \\ 0 & 2 \end{bmatrix}$.
- (h) For a 2×2 square matrix A , find its eigenvalues in terms of t and d , given $\text{Tr}(A) = t$ and $\det(A) = d$.
- (i) If $f(s)$ is Fourier transform of $F(t)$, then show that Fourier transform of $F(at)$ is $\frac{1}{a} f\left(\frac{s}{a}\right)$.
- (j) If ϕ be a function of r only, then show $\nabla^2 \phi = \frac{d^2 \phi}{dr^2} + \frac{2}{r} \frac{d\phi}{dr}$.
- (k) Show that eigenvalues of an anti Hermitian matrix is either zero or purely imaginary.
- (l) Find the Fourier sine transform of e^{-x} .
- (m) Find the Fourier transform of a Dirac Delta Function $f(x) = \delta(x-a)$, ' a ' being some constant.
- (n) Prove that a real matrix is unitary if it is orthogonal.

2. (a) Expand $f(z) = \frac{1}{(z+1)(z+3)}$ in a Laurent series valid for $1 < |z| < 3$. 3
- (b) Show that the Fourier transform of a Gaussian function is also a Gaussian function. 3
- (c) An uncharged conducting sphere of radius R is placed in a uniform electrostatic field $\vec{E} = E_0 \hat{k}$. Find the potential outside the sphere using solution of Laplace's equation in spherical polar coordinates. 4

3. (a) Find the characteristic equation of the matrix. 1+2+2

$$A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & -1 & 4 \\ 3 & 1 & 1 \end{bmatrix}$$

and verify Cayley-Hamilton theorem for it. Hence find A^{-1} .

- (b) Find the Fourier transform of the function 2

$$f(x) = \begin{cases} 1 & , \text{ for } |x| < a \\ 0 & , \text{ for } |x| > a \end{cases}$$

- (c) Show that $\oint_C \frac{e^{zt}}{z^2+1} dz = 2\pi i \sin t$, if $t > 0$ and C is the circle $|z|=3$. 3

4. (a) Two matrices A and B satisfy $(AB)^T + B^{-1}A = 0$. Prove that if B is orthogonal, then A is anti-Symmetric. 3
- (b) If a matrix B commutes with a diagonal matrix A , no. two elements of which are equal, show that, B is a diagonal matrix. 2
- (c) For the following function locate and name the singularities in the finite z -plane and determine whether they are isolated singularities or not. 5

$$f(z) = \frac{z}{(z^2+4)^2}$$

5. (a) If $F(w)$ be the Fourier transform of a function $f(x)$, then show that the Fourier transform of the derivative of $f(x)$ is $-jw F(w)$. 3
- (b) If $w = f(z) = \frac{1+z}{1-z}$, find (i) $\frac{dw}{dz}$ and (ii) determine where $f(z)$ is non analytic. 2
- (c) Solve one dimensional heat equation 5

$$\frac{\partial U(x, t)}{\partial t} = h^2 \frac{\partial^2 U(x, t)}{\partial x^2}$$

Using Fourier transform. Given the initial condition $u(x, 0) = f(x)$.

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WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 4th Semester Examination, 2023

PHSACOR09T-PHYSICS (CC9)

Time Allotted: 2 Hours

Full Marks: 40

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

1. Answer any *ten* questions from the following: 2×10 = 20
- A pion at rest decays into a muon and a neutrino. Show that the kinetic energy of muon is $T_{\mu} = (m_{\pi} - m_{\mu})^2 c^2 / 2m_{\pi}$.
 - What are “space-like interval” and “time-like interval”?
 - Show that the Compton wavelength corresponds to the self-energy of an electron.
 - Calculate the number of light quanta present in green light of 100 W per m² per second. Given $\lambda = 6000 \text{ \AA}$.
 - Show that – “the particle and the associated wave packet move together, i.e., move with the same velocity”.
 - How does a nucleus resembles a liquid drop? Give two points.
 - What do you mean by “Boltzmann weight factor”? Write down the relationship between Boltzmann distribution function and this weight factor.
 - Calculate the ratio of stimulated to spontaneous emission rates for the wavelength $\lambda = 5900 \text{ \AA}$ at 250°C.
 - A hydrogen atom is $5.3 \times 10^{-11} \text{ m}$ in radius. Use the uncertainty principle to estimate the minimum energy an electron can have in this atom.
 - Explain the ‘ultraviolet catastrophe’ in context of black body radiation.
 - The half-life of radon is 3.82 days. What fraction of freshly prepared sample of radon will disintegrate in 10 days?
 - Calculate the number of photons emitted per sec. by a 100 watt sodium lamp. ($\lambda = 5893 \text{ \AA}$ for sodium).
 - Calculate the energy of γ -rays emitted in the β -decay of ${}_{13}\text{Al}^{28}$. Given: the end point energy = 2.81 MeV ; $M({}_{13}\text{Al}^{28}) = 27.9819 \text{ u}$; $M({}_{14}\text{Si}^{28}) = 27.9769 \text{ u}$.
 - A nucleus with $A = 235$ splits into two nuclei of mass numbers in the ratio 2 : 1. Find the radii of the new nucleus.

2. (a) What is 'proper time' and 'proper length'? 2
- (b) In a frame S , the following two events occur: 3
- Event 1: $x_1 = x_0$, $t_1 = \frac{x_0}{c}$, $y_1 = z_1 = 0$
- Event 2: $x_2 = 2x_0$, $t_2 = \frac{x_0}{2c}$, $y_2 = z_2 = 0$
- Find the relative velocity of S' frame relative to S in which the events occur at the same time and what is the t -value?
- (c) The position and momentum of 1 keV electron are simultaneously measured. If its position is located to within 1Å, find the percentage of uncertainty in its momentum. 3
- (d) Establish Bohr's quantization condition on the basis of de Broglie's concept of matter waves. 2
3. (a) What is 'population inversion'? How the population inversion is achieved in the He-Ne gas laser? 1+3
- (b) If R be the radius of the nucleus and $\langle r^2 \rangle$ be the mean squared radius of nuclear charge distribution, show that $R^2 = \frac{5}{3} \langle r^2 \rangle$. 2
- (c) Calculate the α -disintegration energy for the α -particle with energy 5.76 MeV emitted from the nucleus ${}_{83}\text{Bi}^{212}$. 2
- (d) Prove mass of photon is zero. 2
4. (a) Draw a graph indicating stability line. On this graph indicate the β^- -active nuclei. Explain the role of neutrino hypothesis in understanding the β -ray spectrum. 1+1+2
- (b) Discuss the features of B.E./A vs. A curve. 3
- (c) What are the experimental evidences that suggest nuclear shell model? 3
5. (a) Establish a relation between Einstein's Spontaneous and Stimulated coefficients. 3
- (b) Calculate the Surface energy and Coulomb energy for a ${}_{92}^{236}\text{U}$ nucleus. 1+1
- (c) Among ${}_{3}\text{Li}^7$ and ${}_{4}\text{Be}^9$ — Which nucleus is more stable? 2
- (d) How does pair production take place by a high energy γ -rays? Can pair production occur in free space? 2+1

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WEST BENGAL STATE UNIVERSITY
B.Sc. Honours 4th Semester Examination, 2023

PHSACOR10T-PHYSICS (CC10)

Time Allotted: 2 Hours

Full Marks: 40

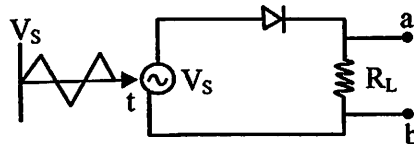
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Question No. 1 is compulsory and answer any two from the rest

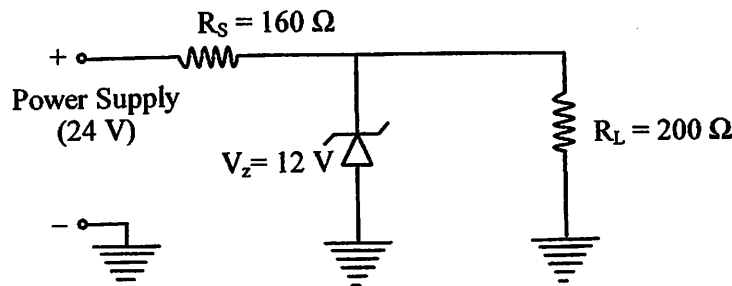
1. Answer any *ten* questions from the following:

2×10 = 20

- (a) For an unbiased p-n junction diode, sketch the variation of space charge, electric field and potential as a function of distance across the junction.
- (b) What is meant by diffusion capacitance of a p-n junction?
- (c) Can a voltmeter measure the built-in-barrier potential across the abrupt or step p-n junction?
- (d) What are the sources of instability of Q-point for CE amplifier?
- (e) Why do Si or Ge diodes not emit light but GaAs diodes do?
- (f) How can you use a bipolar junction transistor (BJT) as a switch?
- (g) Draw the waveform that will be shown in a CRO across a-b



- (h) In the Zener regulator circuit shown below, calculate current through the series resistance (R_S)



- (i) Why the noise behaviours of JFET is less than that of a BJT?
- (j) How is a power amplifier different from a voltage amplifier?
- (k) Explain the current-voltage characteristics of a solar cell.
- (l) A Zener diode with break-down voltage 6 V is connected in series with a 100Ω resistance and a load of $0.5k\Omega$ connected across the diode. The maximum allowable current through the Zener diode is 30 mA. Calculate the operating range of the input voltage.

- (m) If the input of an OPAMP integrator circuit is 1 volt then find and draw the nature of the output voltage. Assume $R = 1\text{ M}\Omega$ and $C = 2\text{ }\mu\text{F}$.
- (n) An amplifier has a voltage gain of -100 and a feedback ratio of -0.04 . Find (i) the output voltage of the feedback amplifier for an input voltage of 60 mV and (ii) find the feedback voltage.
2. (a) A full wave rectifier is operated from 50 Hz supply with 60 V (r.m.s.). It is connected to a load drawing a current of magnitude 200 mA and using $100\text{ }\mu\text{F}$ filter capacitor. Calculate the d.c. output voltage and the r.m.s. value of ripple voltage. Also calculate the ripple factor. 1+2+2
- (b) Draw the circuit diagram of a logarithmic amplifier and a comparator using OPAMP and derive an expression for output voltage for the logarithmic amplifier. 1+2+2
3. (a) Draw a labeled circuit diagram of a two-stage R-C coupled amplifier. Find the mid-frequency gain of the amplifier with the help of an ac equivalent circuit. Explain why the gain of R-C coupled amplifiers falls at high frequencies. 2+3+2
- (b) A two-stage RC coupled amplifier uses transistors having h -parameters $h_{ie} = 1500\text{ }\Omega$ and $h_{fe} = 250$. If the load resistance is $10\text{ k}\Omega$, find the value of the coupling capacitor for having a lower cut-off frequency of 10 Hz . 3
4. (a) Define "Slew rate". Find the input signal maximum frequency for a specified "Slew rate" of an OP-AMP. 1+2
- (b) Is an external input signal necessary for the output of an oscillator? If not, how are oscillations initiated? 2
- (c) Explain the working principle of Colpitts oscillator circuit using BJT. 5
5. (a) What are the fundamental differences between Class A and Class C amplifiers? 2
- (b) Negative feedback reduces the gain of an amplifier still this feedback is widely used, why? 2
- (c) What is JFET? An n -channel Si (having dielectric constant 12) JFET with a channel width of 0.06 cm is doped with a concentration $N_d = 10^{21}\text{ m}^{-3}$. Find the pinch off voltage. 1+3
- (d) An n channel FET has $I_{DSS} = 8\text{ mA}$, $V_p = -4\text{ volt}$. Find V_{GS} that will result in a drain current of 4.5 mA . 2

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WEST BENGAL STATE UNIVERSITY
B.Sc. Honours/Programme 4th Semester Examination, 2023

PHSHGEC04T/PHSGCOR04T-PHYSICS (GE4/DSC4)

Time Allotted: 2 Hours

Full Marks: 40

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*প্রান্তিক সীমার মধ্যস্থ সংখ্যাটি পূর্ণমান নির্দেশ করে।
পরীক্ষার্থীরা নিজের ভাষায় যথা সম্ভব শব্দসীমার মধ্যে
উত্তর করিবে।*

All symbols are of usual significance.

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

১ নং প্রশ্ন আবশ্যিক এবং অন্য প্রশ্ন থেকে যে-কোনো দুটি প্রশ্নের উত্তর দাও

1. Answer any *ten* questions from the following:

2×10 = 20

নিম্নলিখিত যে-কোনো দশটি প্রশ্নের উত্তর দাও:

- Find the dimension of viscosity coefficient.
সান্দ্রতাক্ষের মাত্রা বের করো।
- What is Wavefront?
তরঙ্গমুখ বলতে কি বোঝো ?
- State the differences between interference and diffraction.
ব্যতিচার ও অপবর্তনের মধ্যে পার্থক্যগুলি লেখো।
- What are beats?
স্বরকম্প কাকে বলে ?
- Define nodes and anti-nodes for a standing wave.
স্থানুতরঙ্গের নিম্পন্দ ও সুম্পন্দ বিন্দুর সংজ্ঞা লেখো।
- Write two applications of Polaroids.
পোলারয়েড-এর দুটি ব্যবহার লেখো।
- What is the intensity of a 60 dB Sound?
একটি 60 dB শব্দের তীব্রতা কত ?
- What will be the polarisation angle if the critical angle for a refracting Surface is 30°?
কোনো প্রতিসারক তলের সংকট কোণ 30° হলে তার সমবর্তন কোণ কত হবে ?
- Distinguish between Fresnel and Fraunhofer class of diffraction.
ফ্রেনেল ও ফ্রনহফার শ্রেণী অপবর্তনের মধ্যে পার্থক্য লেখো।
- What is a zone plate?
মণ্ডলফলক কী ?
- What is angle of contact?
স্পর্শকোণ বলতে কি বোঝো ?
- What are the conditions for sustainable interference?
স্থায়ী ব্যতিচারের শর্তগুলি কী কী ?

- (m) Why are the Newton's rings circular?
নিউটন রিংগুলি বৃত্তাকার হয় কেন ?
- (n) Light is an electromagnetic wave. — Explain.
আলো একটি তড়িৎচুম্বকীয় তরঙ্গ — ব্যাখ্যা করো।

Answer any two questions from the following

10×2 = 20

নিম্নলিখিত যে-কোনো দুটি প্রশ্নের উত্তর দাও

2. (a) Establish Poiseuille's equation for flow of a liquid through horizontal capillary tube. 5
অনুভূমিক কৈশিক নলের মধ্যে দিয়ে তরলের প্রবাহ সম্পর্কিত Poiseuille's সমীকরণটি প্রতিষ্ঠা করো।
- (b) Show that in interference phenomenon energy is neither created nor destroyed but is conserved. 3
ব্যতিচার ঘটনায় শক্তির সৃষ্টি বা ধ্বংস কোনটাই হয় না কিন্তু শক্তির সংরক্ষণ হয় — প্রমাণ করো।
- (c) Differentiate between bell and phon. 2
বেল ও ফনের মধ্যে পার্থক্য করো।
3. (a) What is diffraction? Define grating element. 1+1
অপবর্তন বলতে কি বোঝো ? গ্রেটিং উপাদান বলতে কি বোঝায় ?
- (b) What are beats? Show that the beat frequency is equal to the difference between the frequencies of the component oscillations. 1+3
স্বরকম্প কাকে বলে ? দেখাও যে এর কম্পাঙ্ক হবে এর উপাদান দুটির কম্পাঙ্কের পার্থক্যের সমান।
- (c) What do you mean by "Sharpness of Resonance"? 2
"অনুনাদের তীক্ষ্ণতা" বলতে কি বোঝো ?
- (d) State Brewster's Law in polarization of light. 2
আলোর সমবর্তনে ব্রুস্টারের সূত্রটি বিবৃত করো।
4. (a) Derive an expression for the excess pressure inside a curved liquid film. 5
বক্রসরের অভ্যন্তরস্থ অতিরিক্ত চাপের রাশিমালা নির্ণয় করো।
- (b) What are the similarities and dissimilarities between zone plate and convex lens? 2+2
বলয়পাত ও উত্তল লেন্সের মধ্যে সাদৃশ্য ও বৈসাদৃশ্য আলোচনা করো।
- (c) What is double refraction? 1
দ্বিপ্রতিসরণ বলতে কি বোঝো ?
5. (a) Write down the equation of a progressive wave. Explain mathematically the formation of stationary waves by the superposition of two progressive waves. 1+4
চলতরঙ্গের সমীকরণ লেখো। দুটি চলতরঙ্গের উপরিপাতের ফলে কীভাবে স্থানুতরঙ্গের সৃষ্টি হয় তা গাণিতিক বিশ্লেষণ দ্বারা দেখাও।
- (b) Why do two stream line can not intersect each other? 2
দুটি ধারা রেখ কেন একে অপরকে ছেদ করে না ?
- (c) In a Newton's ring experiment, the diameter of 15th ring was found to be 0.590 cm and that of the 5th ring was 0.336 cm. If the radius of curvature of the Plano-convex lens is 100 cm, calculate the wavelength of light used. 3
নিউটন-এর রিং পরীক্ষায় 15th রিং-এর ব্যাস 0.590 cm এবং 5th রিং-এর ব্যাস 0.336 cm। সমতলোত্তল লেন্সের বক্রতা ব্যাসার্ধ 100 cm হলে, ব্যবহৃত আলোর তরঙ্গদৈর্ঘ্য কত ?

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