

212114

M.Sc. (Semester-I) Examination, December 2021

PHYSICS

Paper - II

(Classical Mechanics)

Time Allowed : 3 hours

Maximum Marks : 40

Section-A

(Objective Type Questions)

1×5=5

1. (i) Sum of Lagrangian and Hamiltonian of a system is equal to –
- (a) Twice of Potential energy
 - ☒ (b) Twice of kinetic energy
 - (c) Zero
 - (d) Total energy
- (ii) In variational principle, the line integral of same function between two end points is –
- (a) Zero
 - (b) Infinite
 - ☒ (c) Extremum
 - (d) One

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- (iii) Geosynchronous orbit is located at a distance km from earth surface
- 36000 kilometers
 - 18000 kilometers
 - 2000 kilometers
 - 24000 kilometers
- (iv) 4 velocity is
- space like
 - phase like
 - energy like
 - time like
- (v) The maximum velocity of a material particle can be
- less than the speed of light
 - equal to the speed of light
 - more than the speed of light
 - equal or more than the speed of light.

Section-B
(Short Answers Type Questions) $2 \times 5 = 10$

- Define constraints with suitable examples.
OR
State D'Alembert's principle.
- Explain principle of least action.
OR
Define Poisson's bracket.
- What do you mean by normal modes of small oscillations?

OR

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Explain inertia tensor.

- What are Galelian transformations?
OR
Define 4-vectors.
- Discuss the relativity of man
OR
Define Lagrangian of a dynamic system.

Section-C
(Long Answer type Questions) $5 \times 5 = 25$

- Discuss conservation theorems for many particle systems for linear momentum, angular momentum and energy.
OR
State and prove Hamilton's principle.
- What is Rutherford scattering? Obtain the expression for scattering cross-section.
OR
Define and explain Action-Angle variables.
- Give the theory of small oscillations and find the equation of motion.
OR
What is Euler equation of motion? Deduce Euler equation of motion for a rigid body.

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10. Discuss space-like and time-like intervals with suitable diagram and examples.

OR

Discuss relativistic Lagrangian

11. Give notes on (Any One):

- (a) Relativistic Hamiltonian
- (b) Rotating co-ordinate system
- (c) The equation of motion is poisson's bracket notation.



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M.Sc. (Semester-I) Examination, December 2021

PHYSICS

Paper - I

(Mathematical Physics)

Time Allowed : 3 hours

Maximum Marks : 40

Section-A

(Objective Type Questions)

5×1=5

1. Choose the correct answer :

(i) What is the determinant of a proper orthogonal matrix?

(a) - 1

(b) + 1

(c) 0

(d) None of these

(ii) Generating function for Bessel's function $J_n(x)$ is :

(a)
$$e^{x/2(t-t^{-1})} = \sum_{n=-\infty}^{+\infty} t^n J_n(x)$$

(b)
$$e^{x/2(t+t^{-1})} = \sum_{n=-\infty}^{+\infty} t^n J_n(x)$$

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(c) $e^{x/2}(t-t^{-1}) = \sum_{n=-\infty}^{\infty} t^n J_n(x)$

(d) None of the above

(iii) Laplace Transform is denoted by :

(a) $L[f(t)] = \int_0^{\infty} e^{st} f(t) dt$

(b) $L[f(t)] = \int_0^{\infty} e^{-st} f(t) dt$

(c) $L[f(t)] = \int_{-\infty}^{+\infty} e^{-st/2} f(t) dt$

(d) None of the above

(iv) The application of Green function will be :

(a) To solve the homogeneous differential equation

(b) To solve the inhomogeneous differential equation

(c) To solve the linear differential equation

(d) None of the above

(v) Taylor, Machlaurine and Laurent series is related :

(a) Power series (b) Complex variable

(c) Special series (d) None of the above

Section-B

(Short Answer Type Questions) $5 \times 2 = 10$

2. Define the inner product of two vectors.

OR

Explain the Unitary matrices.

3. Differentiate between cartesian, cylindrical and spherical coordinate system.

OR

If $xJ_n' = nJ_{n-x}J_{n+1}$, then prove that the recurrence relation that : $2J_n' = J_{n-1} - J_{n+1}$.

4. Prove similarity theorem of Fourier transform.

OR

Prove change of scale property of Laplace transform.

5. Define Green's function.

OR

What do you mean by boundary value Problem?

6. Define Residue.

OR

What is meant by singularity of analytical function? Write the names of singularities.

Section-C
(Long Answer Type Questions)

5×5=25

7. Describe the characteristic Roots and characteristic Vectors.

OR

8. State and prove convolution theorem.

8. Prove Rodrigue's formula for Legendre Polynomials.

OR

Write Bessel's differential equation and solve it.

9. Give the definition and properties of the Laplace's transform.

OR

Prove Parseval's theorem for Fourier's transform.

10. Illustrate the Green's function for one dimensional problem.

OR

Explain the Green's function for electrostatic boundary value problem.

11. State and prove Jordan's Lemma to evaluate infinite integral.

OR

Derive the necessary condition for a single valued function $f(z)$ to be analytic.



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M.Sc. (Semester-I) Examination, December 2021

PHYSICS

Paper - IV

(Electronic Devices)

Time Allowed : 3 hours

Maximum Marks : 40

खण्ड-अ

Section-A

(वस्तुनिष्ठ प्रश्न)

(Objective Type Questions)

1×5=5

1. (a) एक टनल डायोड में ऋणात्मक प्रतिरोध क्षेत्र होता है। (सत्य / असत्य)

A Tunnel diode have a negative resistance region. (True / False)

- (b) एक फोटोडायोड जब विकिरण से प्रकाशित (प्रचालित) होता है, हमेशा उत्क्रम अभिनति पर होता है। (सत्य / असत्य)

A photodiode is always reverse biased when (operated) illuminated with radiation. (True / False)

- (c) CMOS लॉजिक परिपथ PMOS एवं NMOS दोनों प्रकार के डिवाइस उपयोग करते हैं।
(सत्य / असत्य)
CMOS logic circuits use both PMOS and NMOS devices. (True / False)
- (d) फीजोइलेक्ट्रिक क्रिस्टल विभिन्न आवृत्तियों पर अलग तरीके से मुड़ता है। (सत्य / असत्य)
The piezoelectric crystal bends in different ways at different frequencies.
(True / False)
- (e) सोलर सेल फोटोवोल्टेइक प्रभाव पर आधारित है।
(सत्य / असत्य)
Solar cell is based on photovoltaic effect. (True / False)

खण्ड-ब

Section-B

(लघु उत्तरीय प्रश्न)

(Short Answer Type Questions)

5×2=10

2. MOSFET एवं MESFET में विभेद कीजिए।
Differentiate between MOSFET and MESFET.

अथवा/OR

गन डायोड एवं टनल डायोड में अंतर स्पष्ट कीजिए।
Differentiate between Tunnel diode and Gunn diode.

3. डायोड लेजर के संदर्भ में लाइट कन्फाइनमेंट फैक्टर, प्रकाशिकी लाभ एवं थ्रेशहोल्ड धारा को परिभाषित कीजिए।
Define light confinement factor, optical gain and threshold current for lasing in context to diode lasers.

अथवा/OR

फोटोडायोड के अभिलाक्षणिक वक्र धारा मोड में दर्शाइए एवं प्रचालन समझाइए।

Draw the characteristic curve of photodiode in current mode of operation. Explain.

4. SRAM और DRAM में अंतर लिखिए।
Differentiate between SRAM and DRAM.

अथवा/OR

मेग्नेटिक डिस्क स्टोरेज (HDD) के संदर्भ में निम्न को परिभाषित कीजिए :

- ट्रेक
- सेक्टर
- सिलिंडर
- डिस्क एड्रेस

In the context of magnetic disk storage (HDD) define the following :

- Track
- Sector
- Cylinder
- Disk address

5. इलेक्ट्रोस्ट्रिक्टिव प्रभाव को संक्षेप में समझाइए।
Explain electro-strictive effects in brief.

अथवा/OR

- मेग्नेटोस्ट्रिक्टिव प्रभाव को संक्षेप में समझाइए।
Explain magnetostrictive effects in brief.

6. टेनडेम संधि सोलर सेल (TJC) का संक्षिप्त विवरण दीजिए।
Give a brief idea of tandem junction solar cell (TJC).

अथवा/OR

- प्रत्यक्ष एवं अप्रत्यक्ष संचरण (direct and indirect transition) अर्द्धचालकों का संक्षिप्त विवरण दीजिए।
Explain in brief direct and indirect transition semiconductors.

खण्ड-स

Section-C

(दीर्घ उत्तरीय प्रश्न)

(Long Answer Type questions)

5×5=25

7. N-चैनल JFET की निम्न बिन्दुओं के अन्तर्गत व्याख्या कीजिए :
- संरचना
 - कार्यविधि
 - पिंच ऑफ वोल्टेज
 - अधिकतम ड्रेन धारा

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Discuss N-channel JFET under following points :

- Construction
- Working
- Pinch off voltage
- Maximum drain current

अथवा/OR

IMPATT डायोड की संरचना, फेब्रिकेशन एवं कार्यविधि की व्याख्या कीजिए।

Discuss structure, device fabrication and principle of operation of IMPATT diode.

8. LED की संरचना एवं कार्यविधि समझाइए। LED का प्रतीक चिह्न एवं गुण बताइए।
Explain structure and working principle of LED. Give symbol and merits of LED.

अथवा/OR

LDR की निम्न बिन्दुओं के अन्तर्गत व्याख्या कीजिए :

- प्रतीक चिह्न
- डार्क प्रतिरोध
- विशिष्ट सुग्राहकता
- कार्यप्रणाली

Discuss LDR under following points :

- Symbol
- Dark resistance
- Specific sensitivity
- Working

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M.Sc. (Semester-I) Examination, December 2021

PHYSICS

Paper - III

(Quantum Mechanics-I)

Time Allowed : 3 hours

Maximum Marks : 40

नोट : प्रश्न पत्र तीन खण्ड 'अ', 'ब' एवं 'स' में विभाजित है। निर्देशानुसार प्रश्न हल करें।

Note : Question paper is divided into 3 sections (A, B, C). Attempt as per the instructions.

खण्ड-अ/Section-A

(वस्तुनिष्ठ प्रश्न)

(Objective Type Questions)

5×1=5

1. सही उत्तर का चयन कीजिए :

Choose the correct answer :

(i) सातत्य समीकरण है -

$$(अ) \frac{dp}{dt} - \vec{\nabla} \cdot \vec{J} = 0 \quad (ब) \frac{dp}{dt} + \vec{\nabla} \cdot \vec{J} = 0$$

$$(स) \frac{d\psi}{dt} - \vec{\nabla} \cdot \vec{J} = 0 \quad (द) \frac{d\psi}{dt} + \vec{\nabla} \cdot \vec{J} = 0$$

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The equation of Continuity is -

(a) $\frac{dp}{dt} - \vec{\nabla} \cdot \vec{J} = 0$ (b) $\frac{dp}{dt} + \vec{\nabla} \cdot \vec{J} = 0$

(c) $\frac{d\psi}{dt} - \vec{\nabla} \cdot \vec{J} = 0$ (d) $\frac{d\psi}{dt} + \vec{\nabla} \cdot \vec{J} = 0$

(ii) सही संबंध है -

(अ) $H\psi = E\psi$ (ब) $H\psi = V\psi$

(स) $H\psi = \nabla\psi$ (द) $H\psi = \phi\psi$

The correct relation is -

(a) $H\psi = E\psi$ (b) $H\psi = V\psi$

(c) $H\psi = \nabla\psi$ (d) $H\psi = \phi\psi$

(iii) समय पर अनिर्भर श्रोडिंजर समीकरण है -

(अ) $\nabla^2\psi + \frac{2m}{\hbar^2}(E - V)\psi = 0$

(ब) $\nabla^2\psi - \frac{2m}{\hbar^2}(E + V)\psi = 0$

(स) $\nabla^2\psi - \frac{\hbar^2}{2m}(E - V)\psi = 0$

(द) $\nabla^2\psi - \frac{\hbar^2}{2m}(V - E)\psi = 0$

Time independent Schrodinger equation is -

(a) $\nabla^2\psi + \frac{2m}{\hbar^2}(E - V)\psi = 0$

(b) $\nabla^2\psi - \frac{2m}{\hbar^2}(E + V)\psi = 0$

(c) $\nabla^2\psi - \frac{\hbar^2}{2m}(E - V)\psi = 0$

(d) $\nabla^2\psi - \frac{\hbar^2}{2m}(V - E)\psi = 0$

(iv) $[\hat{L}_x, \hat{L}_y]$ का मान है -

(अ) $i\hbar\hat{L}_z$ (ब) $i\hbar\hat{L}_z$

(स) $i\hat{L}_z$ (द) Zero

The value of $[\hat{L}_x, \hat{L}_y]$ is -

(a) $i\hbar\hat{L}_z$ (b) $i\hbar\hat{L}_z$

(c) $i\hat{L}_z$ (d) Zero

(3)

- (v) समीकरण $\iiint \psi_i \psi_j^* dv = 0$ प्रदर्शित करती है -
 (अ) सामान्यीकरण (ब) लाम्बिक
 (स) वास्तविक (द) इनमें से कोई नहीं

Equation $\iiint \psi_i \psi_j^* dv = 0$ shows that -

- (a) Normalized (b) Orthogonal
 (c) Real (d) None of these

खण्ड-ब/Section-B

(लघु उत्तरीय प्रश्न)

(Short Answer Type Questions)

5×2=10

1. क्वांटम यांत्रिकी के मूलभूत अभिग्रहित क्या हैं?
 What are the basic postulates of quantum mechanics?

अथवा / OR

क्लाउसर प्रोपर्टी के आइगन फलन को समझाइए।
 Explain closure properties of eigen function.

2. लिनियर वेक्टर स्पेस की अवधारणा को समझाइए।
 Explain the concept of Linear vector space.

अथवा / OR

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हिलबर्ट स्पेस की विवेचना कीजिए।
 Describe Hilbert Space.

3. शून्य बिन्दु ऊर्जा को समझाइए।
 Explain zero point Energy.

अथवा / OR

आण्विक संरचना को परिभाषित कीजिए।
 Define molecular structure.

4. कोणीय संवेग क्या है?
 What is angular momentum?

अथवा / OR

स्पिन तरंग फलन को परिभाषित कीजिए।
 Define spin wave function.

5. परटरबेशन सिद्धांत से आप क्या समझते हैं?
 What do you mean by perturbation theory?

अथवा / OR

WKB सन्निकट की चिरसम्मत सीमाओं को लिखिए।
 Write the classical limit of WKB approximation.

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खण्ड-स/Section-C

(दीर्घ उत्तरीय प्रश्न)

(Long Answer Type Questions)

5×5=25

1. विभव प्राचीर के लिए एक विमीय श्रोडिंजर समीकरण हल कीजिए।

Solve one dimensional schrodinger equation for potential barrier.

अथवा / OR

सामान्यीकरण एवं लाम्बिक आइगन फलन को समझाइए।
Explain normality and orthogonality of eigen function.

2. हाइजेनबर्ग का अनिश्चितता सिद्धांत क्या है? इसको ऑपरेटर के द्वारा निगमित कीजिए।

What is Heisenberg's uncertainty principle?
Derive it through operators.

अथवा / OR

क्रिएशन एवं एन्नीहिलेशन ऑपरेटर क्या हैं? इनको विस्तार से समझाइए।

What is creation and annihilation operators?
Explain in detail.

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3. हाइड्रोजन अणु के त्रिज्यीय भाग के लिए श्रोडिंजर समीकरण हल कीजिए।
Solve radial part of schrodinger equation for hydrogen atom.

अथवा / OR

वर्गाकार विभव कूप के लिए श्रोडिंजर समीकरण को निगमित कीजिए।

Determine schrodinger equation for square well potential.

4. गोलीय ध्रुवीय निर्देशांक के रूप में L^2 और L_z को ज्ञात कीजिए।

Find L^2 and L_z in spherical polar coordinate.

अथवा / OR

विनिमय संबंध प्राप्त कीजिए

$$[\hat{L}_x, x], [\hat{L}_x, \hat{L}_y], [\hat{L}_x, \hat{P}_y]$$

Find commutation relation

$$[\hat{L}_x, x], [\hat{L}_x, \hat{L}_y], [\hat{L}_x, \hat{P}_y]$$

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M.Sc. (Semester-I) Examination, January 2020

PHYSICS

Second (Compulsory)

(Classical Mechanics)

Time Allowed : 3 hours

Maximum Marks : 40

Section-A

✓ **(Objective Type Questions)** **1×5=5**

1. (i) The principle that the total work done by all the forces on a system in static equilibrium is zero is called
- (a) Principle of real work
 - (b) Principle of imaginary work
 - ✓ (c) Principle of virtual work
 - (d) Conservation of work.
- (ii) Coriolis force is a
- (a) Real force
 - (b) Newtonian force
 - (c) Central force
 - ✓ (d) Fictitious force

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(iii) Poisson's bracket is –

- (a) Invariant under canonical transformation
- (b) Variant under canonical transformation
- (c) Both (a) and (b)
- (d) None of the above

(iv) Kepler's laws of planetary motion were proposed for –

- (a) sun
- (b) any star in the galaxy
- (c) any star in the universe
- (d) for all (a) (b) and (c)

(v) The fourth coordinate as per 4-dimensional relativistic space is given by –

- (a) ct
- (b) ic/t
- (c) ic
- (d) ict

Section-B

(Short Answer Type Questions)

2×5=10

2. Define principle of virtual work.

OR

Explain linear momentum and energy conservation laws in Newtonian mechanics.

3. State and describe Lagrange's equation.

OR

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Write down the statement of variational of principle.

4. Define Poisson bracket with example.

OR

State Hamilton-Jacobi Equation.

5. What are small oscillations? Explain.

OR

Explain torque free motion of a rigid body.

6. Explain the symmetries of space and time.

OR

Prove velocity is not invariant under Galilean transformation.

Section-C

(Long Answer Type Questions) 5×5=25

7. State D'Alembert's principle and obtain Lagrange's equation from D'Alembert's principle.

OR

Prove conservation of linear momentum and energy from Lagrange's equation of motion.

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8. Obtain equation of motion of a linear harmonic oscillator using Lagrange's equation of motion.

OR

Define central force. Describe the motion of a particle moving under the influence of a central force.

9. Explain Action Angle variable in detail.

OR

Explain the algebraic properties of Poisson's bracket and find equation of motion in Poisson bracket's notation.

10. Explain Eulerian Co-ordinates and transformation matrices.

OR

What are relating Co-ordinate systems? Explain acceleration in rotating frame.

11. Explain four-dimensional formulation. And define 4-vectors and 4-scalars.

OR

Give detailed note on (any one)

- (a) Covariant Lagrangian
- (b) 4-Momentum

