R6006	Sub. Code
	521101

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Physics

CLASSICAL MECHANICS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

All questions carry equal marks.

1. How any degrees of freedom for are there for a rigid body moving freely in space?

2. What is meant by ignorable coordinate?

3. What are the advantages of Hamiltonian formalism over Lagrangian formalism?

4. State Hamilton's principle.

5. When can you call a body as symmetrical top?

6. Define inertia tensor of a rigid body.

7. State Kepler's second law.

8. Write the two postulates of special theory of relativity.

9. Give any two examples for unstable equilibrium.

10. What do you understand by the term normal modes?

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Describe principle of virtual-work.

Or

(b) Using Lagrangian method, obtain equations of motion for a spherical pendulum.

12. (a) Explain canonical transformation.

Or

(b) Show that if the Hamiltonian is not an explicit function of time, then H is a constant of the motion.

13. (a) State the perpendicular axis theorem and prove it.

Or

(b) Obtain the period of oscillation for compound pendulum.

14. (a) Using center of mass coordinates show that two body central force problem can be reduced to equivalent one body problem.

Or

(b) Obtain the composition rule for two relativistic velocities.

15. (a) Distinguish different kinds of equilibrium with suitable examples.

Or

(b) Consider a system specified by n generalized coordinates. Obtain the n equation of motion near the position of equilibrium.

Part C

(3 × 10 = 30)

Answer any **three** questions.

16. Obtain Lagrange's equation for general systems.

17. State and prove Liouville's theorem.

18. Write in detail about Eulerian angles. Use schematic diagrams wherever necessary.

19. Discuss in detail the consequences of Lorentz transformation.

20. Obtain the normal modes of two coupled masses.

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R6007	Sub. Code
	521102

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Physics

MATHEMATICAL PHYSICS – I

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Mention the physical interpretation of divergence.

2. Prove that the commutative law fails in vector product of two vectors.

3. Find the rank of matrix $A = \begin{bmatrix} 3 & 2 & 5 \\ 1 & 1 & 2 \\ 3 & 3 & 6 \end{bmatrix}$.

4. Prove A is symmetric, prove that adj A is also symmetric.

5. Prove $\lceil n+1 = \lceil n$ where $\lceil n = (n-1)\lceil n-1$.

6. Show that $P_n(x) = (-1)^n P_n(x)$.

7. What is the orthogonality function of Laguerre's polynomials?

8. Find the value of $H_{2n+1}(0)$ in Hermite polynomial function.

9. Find the Fourier transform of $\frac{1}{x}$

10. Write down the linearity property of Fourier transform.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Evaluate the given integral using Stoke's theorem $\int_C \left[(2x - y)dx - yz^2dy - y^2zdz\right]$, where c is the circle $x^2 + y^2 = 1$, corresponding to the surface of sphere of unit radius.

Or

(b) Obtain the expression of gradient in terms of orthogonal system.

12. (a) Find the eigen values of the given matrix $A = \begin{bmatrix} 5 & 0 & 1 \\ 0 & -2 & 0 \\ 1 & 0 & 5 \end{bmatrix}$.

Or

(b) Mention the different types of matrix and explain their any two properties.

13. (a) Evaluate $\int_0^\infty \frac{x^a}{a^x} dx$.

Or

(b) Obtain the Legendre's polynomial $P_n(x)$ of first kind.

14. (a) Obtain the solution and generating function of Laguerre's differential equation.

Or

(b) Deduce the Rodrigue's formula for Hermite polynomials.

15. (a) Write down any two derivatives of Fourier transform.

Or

(b) Solve the inverse Laplace transform of (i) $\log\left(\frac{s^2-1}{s^2}\right)$ and (ii) $\tan^{-1}\left(\frac{1}{s}\right)$.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. (a) State and prove Gauss divergence theorem.

(b) Using Gauss divergence theorem, evaluate $\iint_s \left(x^3 dydz + y^3 dzdx + z^3 dxdy\right)$, where s is the sphere of the radius $x^2 + y^2 = 9$.

17. Using Cayley — Hamilton theorem, find A^{-1}, given that $A = \begin{bmatrix} 2 & -1 & 3 \\ 1 & 0 & 2 \\ 4 & -2 & 1 \end{bmatrix}$.

18. State and prove the orthogonality of Legendre polynomial.

19. (a) Show that $H_n(-x) = (-1)^n H_n(x)$

(b) State and prove the orthogonality of Hermite polynomials.

20. (a) Obtain the equation of Convolution theorem oftwo functions $pppf(x)$ and $g(x)$.

(b) Find the Laplace transform of $\frac{\sin at}{t}$.

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R6008	Sub. Code 521103

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Physics

ELECTRONICS

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. What are avalanche and zener breakdown?

2. Mention the applications of Gunn diode.

3. Why are ordinary transistor called as bipolar transistor?

4. In CE configuration, the voltage drop across load resistance of 1 KΩ is 1.2 V. Determine the base current. Given that $\beta = 60$.

5. Mention any four characteristics of op amp.

6. What are pass band and stop band frequencies?

7. Differentiate between static and dynamic RAM.

8. What is flash memory?

9. Mention the function of comparator in the analog to digital conversion circuit.

10. What is the largest value of output voltage from an 8 bit DAC that produces 1.0 V for a digital output of 00110010?

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Describe the working of laser diode. Mention its applications.

Or

(b) What are p-type and N-type semiconductor? Explain how does it work as diode with neat diagram.

12. (a) What is biasing? Describe the voltage divider biasing with its circuit.

Or

(b) (i) Differentiate between PNP and NPN transistor.

(ii) Explain how a load line graph is drawn for a transistor.

13. (a) Discuss the operation of first order low pass filter. Also sketch its frequency response.

Or

(b) Construct and explain the function of inverting and non inverting amplifier using op amp.

14. (a) What is CCD? Illustrate the principle and working of charge coupled device with diagram.

Or

(b) Give a brief explanation on different memory systems.

15. (a) Explain the operation of voltage to time conversion circuit with relevant diagram.

Or

(b) Draw the D/A converter circuit using op amp with binary weighted resister and explain its operation.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. Construct the schematic symbol of Schottky diode. Describe its working with V — I characteristic curve.

17. (a) Distinguish between JFET and MOSFET.

(b) Describe the circuit and working of silicon controlled rectifier.

18. Sketch the relevant circuit and explain how to generate triangular wave form using op amp.

19. Explain the principle and architecture of content addressable memory. Explain its function.

20. (a) Describe sampling theorem.

(b) Draw the digital ramp ADC and explain its operation.

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R6009	Sub. Code
	521501

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

First Semester

Physics

DIGITAL ELECTRONICS PRINCIPLES

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. What is meant by base or radix of a number system?
2. Write equivalent binary number for the decimal number 121.
3. Give logical expression and truth table of AND and NOT gates.
4. Show that A+ CB = (A + B) (A+C).
5. Define Flip-Flop.
6. What is shift register?
7. Draw the circuit diagram of XOR gate. Give its truth table.
8. What is parallel binary adder?
9. How does magnetic tape work?
10. Expand the following
    (a) MRAM
    (b) DBAM

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Convert hexadecimal number $(F8E6.39)_{16}$ into the equivalent decimal number.

Or

(b) Write note on ASCII code and EBCDIC code.

12. (a) Verify that C (B+C) (A+B+C) = C.

Or

(b) State and Prove De-Morgan's Theorems.

13. (a) Explain the working of J-K Flip-Flop.

Or

(b) Write a note on synchronous counter.

14. (a) Draw the circuit diagram of Half Adder. Explain its function with truth table.

Or

(b) Draw the circuit of 2-bit parallel binary Adder. Explain its function.

15. (a) How does a magnetic disc work? Mention its advantages.

Or

(b) Define the Programmable Logic Devices (PLD). Mention any five applications

Part C

(3 × 10 = 30)

Answer any **three** questions.

16. Convert the following

    (a) $(784122.85)_{10}$ into Hexadecimal number.

    (b) $(695221.42)_{10}$ into Octal number.

17. Simplify the following Boolean function using Karnaugh map F (w, x, y, z,) = $\sum_m$ (0,1,2,4,5,6,8,9,12,13,14)

18. Describe the working of Shift Left Register with neat diagram.

19. Explain the construction and working of 3-bit full subtractor circuit with truth table.

20. What is semiconductor memory? Explain its classification in detail.

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R6010	Sub. Code
	521301

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

Third Semester

Physics

ADVANCED MOLECULAR SPECTROSCOPY

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. Mention the importance of microwave spectroscope.

2. Find the frequency shift due to isotopic change in rotational spectrum.

3. Mention the possible vibrational modes in a vibrating linear triatomic molecule.

4. What is Fermi resonance?

5. What is inverse Raman effect?

6. Mention the conclusions observed from pure rotational Raman spectra.

7. What are the changes observed by chemical shift in NMR spectroscopy?

8. Mention the medical applications of NMR spectroscopy.

9. What is hyperfine interaction?

10. Mention the important characteristics of nuclides involve in Massbauer studies.

Part B $(5 \times 5 = 25)$

Answer **all** questions, choosing either (a) or (b).

11. (a) Describe the diatomic molecule as a non-rigid rotator. Also explain its rotational energy state.

Or

(b) Calculate the intermolecular distance and moment of inertia of HI molecule for the given values H = 1 and I = 127.

12. (a) Brief the instrumentation of IR spectrometer with neat diagram.

Or

(b) Discuss the normal coordinates and normal mode of vibration in a crystal.

13. (a) (i) What is photo acoustic Raman scattering?

(ii) What are the characteristic properties of Raman lines?

Or

(b) Explain the theory of rotational and vibrational spectra of diatomic molecules.

14. (a) Explain the hyperfine interaction and relaxation effect of NMR spectroscopy.

Or

(b) What are dipole - dipole interaction and spin lattice interaction.

15. (a) Describe the working of NQR instrumentation with neat diagram.

Or

(b) What is Massbauer effect? Explain the recoil free emission and absorption in Massbauer spectroscopy.

Part C (3 × 10 = 30)

Answer any **three** questions.

16. (a) What are bond length, bond angle and dipole moment?

(b) If a rigid diatomic molecule treated as two masses m_1 and m_2 joined by a rigid based of length $r_0 = r_1 + r_2$, then calculate the rotational energy levels of these molecules.

17. Discuss the theory of vibrational energy of diatomic molecule as simple harmonic motion.

18. Draw the schematic diagram and explain the instrument for obtaining a Raman spectrum.

19. Explain the principle and quantum theory of NMR spectroscopy. Mention its applications.

20. (a) What is chemical isomer shift?

(b) Explain the applications of Massbauer spectroscopy.

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R6011	Sub. Code
	521302

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

Third Semester

Physics

QUANTUM MECHANICS – II

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. Find the commutation relation, $[J_x, J_z J_y]$.

2. Find the square of the each of the three Pauli spin matrices.

3. What is exchange degeneracy?

4. What are the possible eigen values of Particle exchange operator?

5. Why do the α and β in the Dirac Hamiltonian are matrices rather than numbers?

6. How do you interpret the negative energy states arise from Dirac equation?

7. Define canonical momentum for the field amplitude $\Psi(r,t)$.

8. What is Dirac field.

9. Define differential cross section and total cross section.

10. What is Born approximation?

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) Obtain the matrix representation for the angular momentum, j=1.

Or

(b) Calculate the commutation and anti-commutation properties of the Pauli spin matrices.

12. (a) State Pauli exclusion principle and show that it does not allow multiple occupation of energy levels by half integral spin particles.

Or

(b) Explain Alkali atoms doublet intensity and doublet separation.

13. (a) Construct the Klein-Gordan equation for free particle and solve it.

Or

(b) List the properties of Dirac matrices.

14. (a) Obtain the classical Euler - Lagrange field equations.

Or

(b) Write a note on non-relativistic field quantization.

15. (a) Solve the square well potential scattering.

Or

(b) Obtain necessary expressions for scattering amplitude in the scattering by screened Coulomb potential.

Part C ($3 \times 10 = 30$)

Answer any **three** questions.

16. Elaborate the procedure for addition of two angular momenta and construct the C-G coefficients for j=1/2.

17. Explain in detail about the Hartree equation and Hartree-Fock equation employing independent particle approximation.

18. Solve the Dirac equation for free particle and obtain the plane wave solutions.

19. Quantize the electromagnetic field and obtain its quanta.

20. Using partial wave analysis obtain the expression for the scattering cross section.

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R6012	Sub. Code
	521303

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

Third Semester

Physics

CONDENSED MATTER PHYSICS – I

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** questions.

1. Differentiate between primitive cell and unit cell.

2. Draw the crystal plane (111).

3. Define reciprocal lattice.

4. How do you identify that the given diffraction pattern is from powdered crystal or from single crystal?

5. What is Burgers vector?

6. How do excitons form in a crystal?

7. State Dulong and Petit's law.

8. How does Einstein model for specific heat capacity differ from Debye model?

9. What is Hall effect?

10. Draw the schematic energy band diagram for metal, semiconductor and insulator.

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) List the types of Bravais lattices in three dimensions based on the restriction on conventional cell axes and angles.

Or

(b) What are point groups? How do they differ from space groups? Write any two of the point groups and their elements.

12. (a) Describe Laue method.

Or

(b) Explain neutron diffraction in detail.

13. (a) Explain the surface imperfections such as grain boundary and tilt and twist boundary.

Or

(b) Write a short note on quasi crystals.

14. (a) Obtain the phonon dispersion relation for monoatomic lattices.

Or

(b) Obtain the expressions for density of modes in one and three dimensions.

15. (a) Derive the expression for density of states of electron in three dimension.

Or

(b) Explain how Bloch function is employed to solve the Schrodinger equation for crystals.

Part C

(3 × 10 = 30)

Answer any **three** questions.

16. Explain the crystal structures of NaCl and Diamond with necessary diagrams.

17. Construct reciprocal lattices to SCC and FCC crystal structures.

18. Obtain the expression for Frenkel defects and Schottkey defects.

19. Describe the Debye model of heat capacity for solids.

20. Obtain the energy gap in the Kronig-Penney model.

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R6013	Sub. Code
	521509

M.Sc. DEGREE EXAMINATION, NOVEMBER – 2021

Third Semester

Physics

BASIC CONCEPTS OF INSTRUMENTATION

(CBCS – 2019 onwards)

Time : 3 Hours Maximum : 75 Marks

Part A (10 × 2 = 20)

Answer **all** the questions.

1. Distinguish accuracy and precision.

2. Define backlash.

3. What is break-point frequency?

4. For applying Fourier transform method, what are the conditions imposed on the signals?

5. What are the main advantages of digital transducers?

6. List the types of inductive type transducers.

7. What are the advantages for using thermistors in temperature measurements?

8. How can the elastic elements be employed to measure pressure?

9. State the principle of positive displacement meters.

10. Define decibel.

Part B (5 × 5 = 25)

Answer **all** questions, choosing either (a) or (b).

11. (a) A variable resistance potentiometric transducer having a resistance of 12 kΩ is connected to a dc voltage source of 60V. The voltage output of the transducer is measured by means of a voltmeter of internal impedance of 120 kΩ. Determine impedance loading error at 25% position on the transducer and actual voltage reading observed at this position.

Or

(b) List the types of systematic and random errors and explain each of them.

12. (a) Find the step response of first order and second order systems for the transient input signals by solving appropriate differential equations.

Or

(b) A first order instrument is to measure signals with frequency content up to 100 Hz with an amplitude accuracy of 5%. What is the maximum allowable time constant? What will be the phase shift at 50 Hz?

13. (a) A quartz crystal has charge sensitivity of 2 pC/N. Its dielectric constant is 4.5 and Young's modulus is 9×10^{10} Pa. Find the voltage sensitivity constant.

Or

(b) Explain the three types of frequency domain transducers.

14. (a) Elaborate the working principle of bimetallic thermometer.

Or

(b) Describe the mechanism of metallic resistance thermometers.

15. (a) Draw the schematic diagram of a sound level meter and explain it.

Or

(b) Write a note on nutating disc meter and sliding vane type meter.

Part C $(3 \times 10 = 30)$

Answer any **three** questions.

16. Describe the known distribution functions and compute the necessary expressions for the propagation of errors.

17. How do dynamic characteristics of a measuring system can be improved by compensation? Explain first order and second order system compensation.

18. Discuss in detail about the potentiometric resistance type transducers and inductive type transducers.

19. Explain the different types of manometers. List the desirable characteristics of a manometer fluid.

20. Give detailed account of capacitor type, piezo-electric type and electrodynamic type microphones.

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