SLR-FA-459

Seat No.	

Set P

M.Sc. (Semester – I) (New) (CBCS) Examination Oct/Nov-2019
Physics (Condensed Matter Physics)
MATHEMATICAL TECHNIQUES

Day & Date: Monday, 18-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) Which of the following is an analytic function of the complex variable $z = x + iy$ in the domain $|z| < 2$?
   a) $(3 + x - iy)^7$ b) $(1 + x + iy)^4\ (7 - x - iy)^3$
   c) $(1 - x - iy)^4\ (7 - x + iy)^3$ d) $(x + iy - 1)^{\frac{1}{2}}$

2) Let $u(x, y) = x + \frac{1}{2}(x^2 - y^2)$ be the real part of analytic function $f(z)$ of the complex variable, $z = x + iy$. The imaginary part of $f(z)$ is _____.
   a) $y + xy$ b) xy
   c) y d) $y^2 - x^2$

3) If C is the contour defined by $|z| = \frac{1}{2}$, the value of the integral $\oint_c \frac{dz}{\sin^2 Z}$ is _____.
   a) ∞ b) $2\pi i$
   c) 0 d) πi

4) The Cauchy – Riemann equation in polar form is given as _____.
   a) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}\ and\ \frac{\partial u}{\partial \theta} = \frac{\partial v}{\partial r}$ b) $\frac{\partial u}{\partial r} = r\frac{\partial v}{\partial \theta}\ and\ \frac{\partial u}{\partial \theta} = -\frac{\partial v}{\partial r}$
   c) $\frac{\partial u}{\partial r} = \frac{1}{r}\frac{\partial v}{\partial \theta}\ and\ \frac{1}{r}\frac{\partial u}{\partial \theta} = -\frac{\partial v}{\partial r}$ d) $\frac{\partial u}{\partial r} = \frac{\partial v}{\partial \theta}\ and \frac{1}{r}\frac{\partial u}{\partial \theta} = -\frac{\partial v}{\partial r}$

5) If A, B and C are non-zero Hermitian operators, which of the following relations must be false?
   a) $[A, B] = C$ b) $AB + BA = C$
   c) $ABA = C$ d) $A + B = C$

6) A unitary matrix is defined by the expression: _____.
   a) $U = U^T$, where superscript T means transpose
   b) $U = U^\dagger$
   c) $U = U^*$
   d) $U^{-1} = U^\dagger$

7) Any set of linearly independent vectors can be orthonormalized by the _____.
   a) Pound – smith procedure b) Gram – Schmidt procedure
   c) Sobolev method d) Sobolev – P method

8) What are the eigenvalues of $\begin{pmatrix} 1 & -i \\ i & 1 \end{pmatrix}$?
   a) Both are 0 b) 0 and 1
   c) 0 and -1 d) 0 and 2

9) The differential equation of all parabolas having axis parallel to y- axis is _____.

a) $\frac{d^3x}{dy^3} = 0$ b) $\frac{d^3y}{dx^3} = 0$

c) $\frac{d^3y}{dx^3} + \frac{d^2y}{dx^2} = 0$ d) $\frac{d^2y}{dx^2} = 0$

10) The degree of $x\frac{d^2y}{dx^2} + \sin\frac{dy}{dx} = 0$ is _____.

a) 1 b) 2

c) 3 d) Not defined

11) Which of the following is an "even" function of t?

a) $t^2 - 4t$ b) $t^3 + 6$

c) t^2 d) $\sin(2t) + 3t$

12) What are the conditions required for a signal to fulfill to be represented as Fourier series?

a) Dirichlet's conditions b) Gibbs phenomenon

c) Fourier conditions d) Fourier phenomenon

13) Which of the following pairs of the given function f(t) and it's Laplace transform f(s) is NOT CORRECT?

a) $f(t) = \delta(t), f(s) = 1, (singularity\ at + 0)$

b) $f(t) = 1, f(s) = {}^{1}/_{s}, (s > 0)$

c) $f(t) = \sin kt, f(s) = \frac{s}{s^2 + k^2}, (s > 0)$

d) $f(t) = t\, e^{kt}, f(s) = \frac{1}{(s-k)^2}, (s > k, s > 0)$

14) The Fourier transform $\int_{-\infty}^{\infty} dx\, f(x)e^{ikx}$ of the function $f(x) = \frac{1}{x^2+2}$ is ___.

a) $\sqrt{2}\pi e^{-\sqrt{2}|k|}$ b) $\sqrt{2}\pi e^{-\sqrt{2}K}$

c) $\frac{\pi}{\sqrt{2}} e^{-\sqrt{2}K}$ d) $\frac{\pi}{\sqrt{2}} e^{-\sqrt{2}|K|}$

Q.2 A) Answer the following questions. (Any Four) **08**

1) Find the solution of the differential equation. $\frac{d^2y}{dx^2} - 7\frac{dy}{dx} + 6y = 0$

2) Classify the singularities and calculate the residue for $f(z) = \frac{A(z)}{\sin Z}$, where $A(z)$ is analytic and contains no zeros.

3) Find the eigenvectors of $H = \begin{pmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix}$

4) Expand $f(x) = x$ for $-\pi \le x \le \pi$ in a Fourier series.

5) From the convolution theorem show that

$$\frac{1}{s}f(s) = \mathcal{L}\left\{\int_0^t F(x)dx\right\}$$

Where $f(s) = \mathcal{L}\{f(t)\}$

B) Write short notes. (Any Two) **06**

1) The Cauchy Principal Value
2) Properties of Fourier series
3) Linear dependent and independent set of vectors

Q.3 A) Answer the following questions. (Any Two) **08**

1) Show that the eigenvalues of a Hermitian matrix are all real.
2) State and prove Cauchy's Integral theorem.
3) Solve the differential equation $\frac{d^2y}{dx^2} - 2\frac{dy}{dx} + y = 2\cos x$

B) Answer the following (Any One) **06**

1) Using partial fraction expansion, show that for $a^2 \neq b^2$,

$$\mathcal{L}^{-1}\left\{\frac{s^2}{(s^2+a^2)(s^2+b^2)}\right\} = \frac{1}{a^2-b^2}[a\sin(at) - b\sin(bt)]$$

2) By use of the residue theorem, evaluate $\int_0^{2\pi} \frac{d\theta}{(a+b\cos\theta)^2}$

where $a > b > 0$.

Q.4 A) Answer the following questions. (Any Two) **10**

1) Find the eigenvalues and eigenvectors of $A = \begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$
2) Find the Fourier transform of Gaussian distribution functions.
3) Solve the differential equation, $y^3\frac{dy}{dx} + \frac{1}{x}y^4 = x$

B) Answer the following questions. (Any One) **04**

1) If $f(x) = x + x^2$ is expanded in a Fourier series then show that

$$\sum_{n=1}^{\infty} \frac{1}{n^2} = \frac{\pi^2}{6}$$

2) Find the value of integral $P\int_{-\infty}^{\infty} \frac{e^{ix}}{x}dx$

Q.5 Answer the following questions. (Any Two) **14**

a) Develop the Fourier expansion for $f(t) = \begin{matrix} \sin\omega t & 0 \leq \omega t \leq \pi \\ -\sin\omega t & -\pi \leq \omega t \leq 0 \end{matrix}$

b) Find a matrix s that diagonalizes.

$$A = \begin{pmatrix} 3 & -2 & 0 \\ -2 & 3 & 0 \\ 0 & 0 & 5 \end{pmatrix}$$

c) By use of the three-dimensional Fourier transform method, solve poisson's equation for the electrostatic potential function.

$$\nabla^2\phi(\vec{r}) = -\frac{\varrho(\vec{r})}{\epsilon}$$

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Set P

M.Sc.(Semester – I) (New) (CBCS) Examination Oct/Nov-2019
Physics (Condensed Matter Physics)
CONDENSED MATTER PHYSICS

Day & Date: Tuesday, 05-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 Fill in the blanks by choosing correct alternatives given below. **14**

1) Relative permittivity (ε_r) of the air is _____.
   a) 2 b) 0.5
   c) 1 d) 0

2) Reciprocal lattice vector G = _____.
   a) K'-K b) K - K '
   c) K ' + K d) $(K'+K)^2$

3) The electronic polarizability α_e of a monoatomic gas is _____.
   a) $4\pi\varepsilon_0$ b) $4\pi\varepsilon_0 R$
   c) $4\pi\varepsilon_0 R^3$ d) $4\pi\varepsilon_0^2$

4) Elemental solid dielectric has only _____ polarization.
   a) electronic b) ionic
   c) orientational d) all

5) The Fermi energy of intrinsic semiconductor is _____.
   a) $\frac{Ec+Ev}{2}$ b) $\frac{Ec+Ed}{2}$
   c) $\frac{Ec-Ev}{2}$ d) $\frac{Ec+Ea}{2}$

6) Number of tetrad axis in simple cubic system are_____.
   a) 2 b) 3
   c) 4 d) 8

7) Plane cut to negative x axis have the miller indices _____.
   a) 011 b) 001
   c) 110 d) 100

8) Which of the following cannot actually move?
   a) Majority carriers b) Ions
   c) Holes d) Free electron

9) Effective mass is equal to _____ mass for free electron.
   a) mean b) real
   c) residual d) zero

10) In an _____ polarization, electronic cloud is coming to one side to form dipole.
   a) orientational b) ionic
   c) electronic d) optical

11) FCC structure contains the contribution of _____ atoms.
   a) Two b) four
   c) nine d) six

12) In monoclinic lattice _____ are equal.
a) a, b, c b) α, β, γ
c) h, k, l d) none of these

13) Conductivity in metal depends on _____ mobility.
a) proton b) neutron
c) electron d) none of these

14) Penetration depth varies with _____.
a) pressure b) Temperature
c) volume d) Width

Q.2 A) Answer the following (Any Four) **08**
1) Define packing fraction.
2) Define coordination number.
3) What is dielectric loss?
4) What is penetration depth?
5) What is rectification?

B) Write short notes (Any Two) **06**
1) Brillion zones.
2) Effective mass of the electron.
3) Schottky barrier.

Q.3 A) Answer the following (Any Two) **08**
1) Derive the rectifier equation.
2) Write about orientational polarization.
3) Explain thermal properties of the superconductor.

B) Answer the following (Any One) **06**
1) Explain dielectrics loss angle and power factor.
2) Explain the defects in solids.

Q.4 A) Answer the following (Any Two) **10**
1) Show the absence of fivefold symmetry.
2) Explain Missner's effect.
3) Write about Reciprocal Lattice.

B) Answer the following (Any One) **04**
1) Distinguish direct and indirect band gap semiconductors.
2) Write about London equation.

Q.5 Answer the following (Any Two) **14**
a) Write about the behavior of electron in a periodic potential.
b) Give the theory of DC Josephson's effect.
c) Give the expression for inter planer spacing (d).

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Set P

M.Sc. (Semester - I) (New) (CBCS) Examination Oct/Nov-2019
Physics (Condensed Matter Physics)
ANALOG & DIGITAL ELECTRONICS

Day & Date: Thursday, 07-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.

Q.1 Fill in the blanks by choosing correct alternatives. **14**

1) In a differential amplifier, the configuration is said to be an 'unbalanced output', if _____
   a) Output voltage is measured between two collectors
   b) Output is measured with respect to ground
   c) Two input signals are used
   d) All the above

2) An ideal operational amplifier has _____
   a) infinite output impedance b) zero input impedance
   c) infinite bandwidth d) all of the above

3) Another name for a unity gain amplifier is _____
   a) difference amplifier b) comparator
   c) single ended d) voltage follower

4) What should be the value of input resistance for an ideal voltage amplifier circuit?
   a) Zero b) Unity
   c) Infinity d) Unpredictable

5) The use of negative feedback _____
   a) reduces the voltage gain of an Op-amp
   b) makes the Op-amp oscillate
   c) makes linear operation possible
   d) answers (a) and (b)

6) Hartley oscillator is commonly used in _____
   a) Radio receivers b) Radio transmitters
   c) TV receivers d) None of the above

7) A Wein-bridge oscillator uses which feedback?
   a) only positive b) only negative
   c) both negative and positive d) none of the above

8) Circuit which consist of a quasi-stable state is called _____
   a) bistable circuit b) monostable circuit
   c) tri stable circuits d) tristate circuit

9) What is the range of the voltage level of the LM317 adjusted voltage regulator?
   a) 0 V to 5 V b) 1.2 V to 37 V
   c) -5 V to -24 V d) 5 V to 24 V

10) Simplify Y = AB'+ (A' + B) C
   a) AB' +C
   b) (A + B') (C'+D)
   c) (A'+B) (C'+D)
   d) (A+B') (C+D')

11) The EXCLUSIVE NOR gate is equivalent to which gate followed by an inverter.
   a) OR
   b) AND
   c) NAND
   d) XOR

12) The basic latch consists of _____
   a) two inverters
   b) two comparators
   c) two amplifiers
   d) two adders

13) Which is the 16-bit register for 8085 microprocessor?
   a) stack pointer
   b) accumulator
   c) register B
   d) register C

14) A bus connected between the CPU and main memory that permits transfer of information between main memory and CPU is known as _____
   a) DMA bus
   b) memory bus
   c) address bus
   d) control bus

Q.2 A) Answer the following questions. (Any Four) **08**

1) Define open loop and closed loop amplifier circuits.
2) Explain CMRR.
3) Explain the conditions of the sustainable oscillator.
4) Define AND gate. Write its logic symbol and truth table.
5) State and prove De Morgan's theorem.

B) Write Notes. (Any Two) **06**

1) Fixed regulators.
2) Explain the concept of virtual ground.
3) Dual input balance output differential amplifier.

Q.3 A) Answer the following questions. (Any Two) **08**

1) Discuss the effect of feedback on closed loop gain.
2) Draw the circuit diagram and output wave forms of triangle wave generator.
3) Explain registers in 8085.

B) Answer the following question. (Any One) **06**

1) Derive an expression for input resistance and bandwidth of voltage series negative feedback amplifier.
2) Write logic diagram and truth table of RS flip flop and explain its working.

Q.4 A) Answer the following questions. (Any Two) **10**

1) A phase shift oscillator uses register R=220 Ohms, what should be the capacitance value if the capacitor required for a phase shift oscillator of frequency of 120 Hz and 1 KHz.
2) Derive an expression for output resistance with feedback in a closed loop amplifier.
3) Write an assembly language program to add two 8 bit numbers.

B) Answer the following questions. (Any One) **04**

1) Derive an expression for op. amp as integrator.
2) With a neat circuit diagram explain switching regulator.

Q.5 Answer the following questions. (Any Two) **14**

1) With a near circuit diagram explain master slave JK flip flop.

2) With a near circuit diagram explain the working of LC tunable shift oscillator.

3) Write an assembly language program for 2's complement of two 16-bit numbers.

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Seat No.	

Set P

M.Sc. (Semester – I) (New) (CBCS) Examination Oct/Nov-2019
Physics (Condensed Matter Physics)
CLASSICAL MECHANICS

Day & Date: Saturday, 09-11-2019 Max. Marks: 70
Time: 11:30 AM To 02:00 PM

Instructions: 1) All questions are compulsory.
2) Figures to the right indicate full marks.
3) Use of non-programmable calculator is allowed.

Q.1 A) Fill in the blanks by choosing the correct alternatives given below. **08**

1) The configuration space is _____ dimensional space.
   a) 6N b) 3N
   c) 2N d) 4N

2) The Poisson bracket [u, q_j] = _____.
   a) $-\partial u/\partial p_j$ b) $+\partial u/\partial p_j$
   c) $\partial u/\partial q_j$ d) $-\partial u/\partial q_j$

3) The generating function F_2(q, P, t) generates _____ transformations.
   a) exchange b) identity
   c) none d) infinite

4) The Hamiltonian is defined as _____.
   a) H = T-V b) H = T.V
   c) H = T+V d) H = T/V

5) In Lagrangian the motion of the system has been described by the _____ consideration.
   a) force b) momentum
   c) energy d) acceleration

6) If mi $\ll$ m_2, then the centre of mass of system coincides with the centre of mass of _____.
   a) m_1 b) m_2
   c) in between m_1 and m_2 d) away from m_1

7) If $\in > 1$, then the shape of the orbit formed will be _____.
   a) Ellipse b) Circle
   c) Hyperbola d) Parabola

8) In mechanics the action is _____.
   a) Σ q.p b) Σ q + p
   c) Σ q - p d) Σ $q^2.p^2$

B) State True or False: **06**

1) The Lagrangian equation from D'Alembarts principle is based on Newton's laws.
2) [u , c] = 0 where c is constant.
3) The variational principle associated with Hamiltonian formulation is called the principle of least action.
4) The Hamiltonian formulation is more advantageous than Newtonian.
5) In the configuration space system is having unique path.
6) In mechanics the addition of q and p is called action.

Q.2 A) Answer the following questions (Any Four) **08**

1) What is phase space? Explain it with one example.
2) Define Poisson Bracket.
3) Show that the angular acceleration is the same in fixed and rotating frames.
4) Explain the concept of the inertial and non-inertial frames.
5) Explain the term differential scattering cross section.

B) Write short Notes. (Any Two) **06**

1) Holonomic and non- holonomic constraints
2) Properties of motion under central force field
3) Shapes of orbit formed under central force field

Q.3 A) Answer the following questions. (Any Two) **08**

1) State the Hamilton's variational principle and derive the Lagrange's equation of motion form it.
2) Show that the transformation P = q cot p and Q = log{(sin p)/q} is canonical.
3) Show that the poisson bracket obeys distributive law of algebra.

B) Write Short notes. (Any One) **06**

1) Rutherford scattering
2) Lagrange's equation of motion for one dimensional linear harmonic oscillator.

Q.4 A) Answer the following questions. (Any Two) **10**

1) Distinguish between the configuration space and phase space.
2) What is canonical transformation? Discuss the exact differential condition to show that the transformation is to be canonical.
3) Discuss the different types of generating functions useful for canonical transformations.

B) Write Short notes. (Any One) **04**

1) Advantages of Hamiltonian mechanics over the Lagrangian and Newtonian mechanics.
2) Principle of least action.

Q.5 Answer the following questions. (Any Two) **14**

1) Show that Poisson Brackets remains invariant under canonical transformations.

2) Show that the generating function $F = \sum q_k Q_k$ produce exchange transformation.

3) How a two body problem does reduce to a single body problem? Derive the equation of motion for it?