CENTRAL UNIVERSITY OF HARYANA

Term End Examination December-2018

Name of Programme	:	**M.Sc. Physics**	
Year & Semester	:	**December 2018, First Semester (Regular)**	
Course Name	:	**Classical Mechanics**	
Course Code	:	**SPMS PHY 01 102 CC 3104**	
Maximum Marks	:	**70**	**Duration: 3 Hrs**

Instructions:

1. Question no. 1 has seven parts and students need to answer any four. Each part carries three and half Marks.
2. Question no. 2 to 5 have three parts and student need to answer any two parts of each question. Each part carries seven marks.

Q1.

a) State and explain D Alembert's principle.

b) Define the terms: generalized coordinate, generalized momentum, generalized force and cyclic coordinate

c) State and explain Liouville's Theorem.

d) Distinguish between stable and unstable equilibria.

e) State and explain the principle of least action.

f) Define Lagrange and Poisson brackets for entities which are functions of two variables q, p.

g) What are normal coordinates and free vibrations for small oscillations?

Q2.

a) State Hamilton's principle and derive Lagrange's equations using it for conservative systems and velocity dependent potentials.

b) What are fictitious potential and fictitious force. For attractive inverse square law of force, classify the orbit for total energy E for (i) $E>0$, (ii) $E=0$ and (iii) $E<0$.

c) State and prove Noether's Theorem.

Q3.

a) Define generalized momentum. Derive Hamilton's canonical equation of motion.

b) What is Routhian ? Describe Routh's procedure for solving mechanical problems.

c) Discuss the physical significance of Hamiltonian of a system. State and explain principle of least action.

Q4.

a)Define Poisson's bracket. Show that Poisson bracket is invariant under canonical transformation.

b) Solve linear Harmonic oscillator problem using Hamilton Jacobi method.

c) State and prove Jacobi's identity.

Q5.

a) Discuss free vibrations of linear triatomic molecule. Derive the expression for eigen values of eigen value equation for linear triatomic molecule.

b) Derive expression for amplitudes of vibrations (i.e. coefficients) for each mode for linear triatomic molecule. Comment on the degenerate modes of symmetrical triatomic molecule.

c) State and prove Euler's theorem.

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End Semester Examinations (Regular/Reappear) Dec 2018

Programme: MSc. Physics | Session: 2018-19

Semester: First Semester | Max. Time: 3 Hours

Course Title: Quantum Mechanics | Max. Marks: 70

Course Code: SPMS PHY 01 103 CC 3104

Instructions:

1. Question no. 1 has seven parts and students need to answer any four. Each part carries three and half Marks.

2. Question no. 2 to 5 have three parts and student need to answer any two parts of each question. Each part carries seven marks.

Q 1. (4X3.5=14)

a) A plastic disk rotates with angular velocity 100 rad s^{-1}. Estimate, in units of $\hbar$, the order of magnitude of the angular momentum.

b) Write down the Pauli Spin Matrices.

c) What are operators? State expressions of Ladder operators L_+ and L_-.

d) Use Dirac notation to prove that Eigen values of a Hermitian operator are real.

e) Explain unitary operator. Show that the norms of a state function do not change under a unitary transformation.

f) Prove that $[L^2, L_x] = 0$

g) State the condition for the validity of WKB approximation.

Q 2. (2X7=14)

a) (i) Normalize the wave function $\Psi(x) = A \exp(-ax^2)$

Where A and a are constants over the domain $[-\infty, +\infty]$

(ii) Find the eigenfunction and eigenvalue of the operator d/dx.

b) Describe the postulates of quantum mechanics.

c) What are Dirac's bra and ket vectors? With respect to these vectors, define Hilbert space. Write expressions for the norm and scalar product in this space and define the basis of Hilbert space.

Q3. (2X7=14)

a) A particle of mass m is moving in a potential well :

$V(x) = V_0$ for $x < -a$

$= 0$ for $-a < x < a$

$= V_0$ for $x > a$

When energy of the particle is $E < V_0$, then show that there exists at least one bound state.

b) Using the Schrodinger steady state equation, obtain the energy Eigen values of a particle enclosed in 3 dimensional rigid box. What are degenerated states?

c) Write the radial part of Schrödinger equation for hydrogen atom. Solve it to find out the energy eigenvalues and energy eigenfunctions.

Q 4. (2X7=14)

a) Starting from angular momentum commutation rules, determine Eigen values of J^2 and J_z. What are ladder operators?

b) Obtain Clebsch-Gordan coefficients for a system of two non interacting particles with angular momenta : $j_1 = ½$ and $j_2 = ½$.

c) (i) The un-normalized wave function of a particle in a spherically symmetric potential is given by $\psi(r) = zf(r)$ where $f(r)$ is a function of the radial variable r. Calculate the eigenvalue of the operator L^2 (namely the square of the orbital angular momentum).

(ii) If L_x, L_y, L_z, are the components of the angular momentum operator in three dimensions, then simplify the commutator $[L_x, L_xL_yL_z]$.

Q 5. (2X7=14)

a) Discuss perturbation theory and calculate the second order correction to the energy for the time independent non-degenerated perturbation theory.

b) Derive an expression for scattering cross section for low energy. Show that low energy scattering is isotropic in nature.

c) Show that in Born approximation the scattering amplitude is Fourier transform of scattering potential.

I Semester Term End Examination December 2018
PG Programme (2018-19 session)
Branch: M.Sc. (Physics)

Course Code: SPMS PHY 01 104 CC 3104
Course Title: Electronics

Max Time: 3hrs
Max Marks: 70

Note:
Question Number **one** is compulsory and carries total 14 marks (Each sub Question carries two Marks).
Question Numbers 2(two) to 5(five) carry fourteen marks each with internal choice.

PART -I

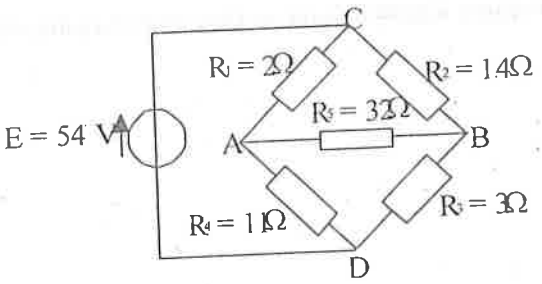
Question No.1
(a) Draw the transfer characteristics of differential amplifier.
(b) Differentiate between ohmic and rectifying contracts with suitable examples.
(c) Is any gate current required to drive a JFET into the cut-off state? Why or why not?
(d) State Kirchoff's current law.
(e) Discuss race-around conditions is flip-flops and its resolution.
(f) Draw the neat and clean diagram for single input, balanced output differential amplifier
(g) Add 58-170 using2's compliment method.

PART –II

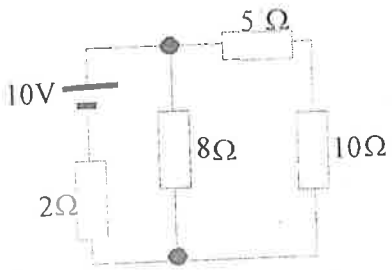
Unit-I

Question No.2 (a) Derive the expression for delta to star network conversion. (7)

2(b) A Wheatstone Bridge network is shown in figure. Calculate the current flowing in the 32 Ω and its direction, using Thevenin's theorem. Assume the source of e.m.f. to have negligible resistance.



Or
Question No. 2 (a) Use Thevenin's theorem to find the current flowing in the 10 Ω resistor for the circuit shown in Figure. (7)



(b) State and Prove maximum power transfer theorem. (7)

Unit-II

Question No.3 (a). What do you understand by p-n junction? Explain the construction and working of JFET. (10)

3(b) Determine the duty cycle of oscillations for astable multivibrator using IC-555 timer. Given that $R_a = R_b = 2\ K\Omega$ and $C = 1000\ PF$. (4)

Or

Question No.3 (a) For the subtractor circuit using op-amp, input voltages are v1= 7V and v2 =3Vand R1=10 KΩ and R2= 20 KΩ calculate the output voltage. (4)

(b) Explain term input offset voltage, offset current and open loop voltage gain. Explain construction and working of op-amp as integrator. (10)

Unit-III

Question No. 4(a) Explain working of J-K flip flop with logic diagram and truth table. (6)

(b) With neat and clean diagram, explain working of decade counter. (4)

(c) Reduce the expression $F(a,b,c,d) = \prod (2,4,5,7,8,14)$. (4)

Or

Question No. 4(a) Design the full adder and realise sum and carry outputs using NAND-NAND gate. (4)

(b) Explain 4 bit Asynchronous counter with block diagram, truth table and timing diagram. (6)

(c) Reduce the expression $F(a,b,c,d) = \sum(1,2,3,4,6,8,10)$. (4)

Unit-IV

Question No. 5(a) Explain the operation of digital to analog converter (DAC) and analog to digial converter (ADC) (8)

(b) Explain construction and working of phase shift oscillator. Write advantages of phase shift oscillator also. (6)

(c)

Or

Question No. 5(a) Draw block diagram of regulated power supply and explain each block in short. (8)

(b) What is Barkhausen criterion. Explain construction and working of wein bridge oscillator. (6)

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Jant-Pali, Mahendergarh, Haryana
Term End Examination December-2018

Name of Programme	: M.Sc. Physics	
Year & Semester	: December 2018, First Semester	
Course Name	: Mathematical Methods in Physics-I	
Course Code	: SPMS PHY 01 101 CC 3104	
Maximum Marks	: 70	Duration : 3 Hrs

Note:
All Questions are compulsory.
Attempt any Four parts in Question No. 1, each part carries 3.5 marks.
Attempt any two parts from each questions, Question 2 to 5. Each part carries 7 marks.

1. (a) How do you specify the Covariant and contravariant components of a vector in a 2 dimensional oblique (or non orthogonal) coordinate system.

   (b) Show that the quadratic form $Q = g_{ab}x^a x^b$ is an affine invariant provided (g_{ab}) is a covariant affine tensor.

   (c) Prove using complex analysis that $\sinh(x + iy) = \sinh x \cos y + i\cosh x \sin y$.

   (d) Comment on the analyticity of $Im(z)$ and $Re(z^2)$ where z is a complex number.

   (e) State and prove convolution theorem.

   (f) Show that the real space representation of Maxwell's Equation $\nabla \cdot E = \rho/\epsilon_0$ and $\nabla \times E = -\frac{\partial B}{\partial t}$ simplyfy to simple algebric equation in Fourier space.

   (g) What do you understand by interpolation and Extrapolation of a function. Define the forward and backward difference of a function as used in different formulas of interpolation.

2. (a)The covariant vector A_i is the gradient of a scalar. Show that the difference of covariant derivatives $A_{i;j} - A_{j;i}$ vanishes.

   (b) If F_{ik} is an antisymmetric tensor then show that $Z_{ikl} = \frac{\partial F}{\partial x^i k_l} + \frac{\partial F}{\partial x^k l_i} + \frac{\partial F}{\partial x^l i_k}$ is a third-rank tensor

   (c)Comment on the symmetric nature of stress and strain tensor by giving their definition Write down Hooke's Law and show that Elasticity tensor is a 4th rank tensor.

3. (a)Use Cauchy integral formula and prove that if the Legendre polynomial of degree n is defined by $P_n(x) = \frac{1}{2^n n!}(\frac{d}{dx})^n(x^2-1)^n$ then $P_n(z) = \frac{1}{2^n}\frac{1}{2\pi i}\oint \frac{(p^2-1)^n}{(p-z)^{n+1}}dp$

(b) (i) Find the Taylor series about the origin for $f(z) = \frac{1}{1+z-2z^2}$

(ii)Find all possible Laurent expansions about $z = 0$ of $f(z) = \frac{1+2z^2}{z^3+z^5}$ and specify the regions in which they are valid.

(c) (i)Find the value of the integral $^{H}_{c}f(z)dz$ for $f(z) = \frac{z^{99}exp(\frac{1}{z})}{z^{100}+1}$ where C is counterclockwise around the circle $|z| = 2$.

(ii)Evaluate the integral $I = \int_{-\infty}^{\infty}\frac{x\sin x}{x^2+1}dx$

4. (a) Find the value of $I = \int_{-\infty}^{\infty}\frac{\sin^2 x}{x^2}dx$ from the Parsevals theorem. Find the Fourier transform of

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

(b) Use the fourier transform of derivatives to show that $F\{e^{-\alpha x}\} = \sqrt{\frac{2}{\pi}}\frac{k}{\alpha^2+k^2}$

(c) Obtain the Fourier transform, $g(\omega)$, of the Gaussian function $f(t) = Nexp(-\frac{1}{2}ct^2)$ and verify that the product of uncertainities (in time space and frequency space) has a unique value *i.e.* $\Delta t\Delta\omega = \frac{1}{2}$

5. (a) Describe with diagram, the secant method for finding the roots of a function. Use it to calculate the root of $x^3 = 25$ up to 2 decimal point accuracy

(b) Describe Lagrange method for interpolation of a polynomial. Use it to calculate thevalue of the function $f(x)$ at x=5.8 given that :

x	2	5	7	10
f(x)	1.3	118.3	336.3	993.3

(c) Derive 2nd order Runge-Kutta method formula to obtain solution of a general firstorder differential equation $\frac{dy}{dx} = f(x,y)$ with given initial condition $y(x_0) = y_0$. Use this formula to calculate $\frac{dy}{dx} = \frac{5x^2-y}{e^{x+y}}$ given that $y(0) = 1$

CENTRAL UNIVERSITY OF HARYANA

End Semester Examinations (Regular/Reappear) Dec 2018

Programme: M.Sc (Physics) (GEC) | Session: 2018-19

Semester: I / III | Max. Time: 3 Hours

Course Title: Modern Optics | Max. Marks: 70

Course Code: SPMS PHY 01 102 GEC 3104

Instructions:

1. Question no. 1 has seven sub parts and students need to answer any four. Each sub part carries three and half Marks.

2. Question no. 2 to 5 have three sub parts and students need to answer any two sub parts of each question. Each sub part carries seven marks.

Question No. 1. (4X3.5=14)

a) What is stimulated emission process in Laser?

b) Explain Snell law.

c) Discuss the total internal reflection process.

d) Describe briefly "Thin film: coating design".

e) Explain the Principle of rectilinear propagation of light.

f) What is population inversion? Why it is necessary condition for laser action.

g) Explain the electromagnetic spectrum in visible region.

Question No. 2. (2X7=14)

a) What do you mean by the term polarization? How will you produce plane polarized light by refraction.

b) Explain the Fermat's principle of extremum of path. Deduce the law of reflection from it.

c) Establish a relation between refractive index and critical angle for a medium.

Question No. 3. (2X7=14)

a) What are Fraunhofer diffraction and Fresnel diffraction? Differentiate between them.

b) Write short notes on

(i) Holography (ii) Reflection model of thin films.

c) Establish Fresnel's relations for reflection and transmittance.

Question No. 4. (2X7=14)

a) Explain various characteristics of a Laser beam.

b) Briefly explain absorption, spontaneous emission and stimulated emission of radiation and give suitable examples.

c) Derive the relationship between Einstein's coefficients A and B and discuss the importance.

Question No. 5. (2X7=14)

a) Explain the working of multicolor LED. What are advantages of a LED over a ordinary lamp or bulb? Discuss.

b) What is optical fiber? Explain. List advantages and disadvantages of optical fibres.

c) Write short notes on

(i) P-n junction diode.

(ii) Photonic band gap crystal.

CENTRAL UNIVERSITY OF HARYANA

End Semester Examinations, Dec 2018

Programme: M.Sc. (Physics) **Session:** 2018-19

Semester: III **Max. Time:** 3 Hour

Course Title: Advanced Statistical Mechanics **Max. Marks:** 70

Course Code: SPMS PHYS 01 305 DCEC 3104

Instructions:

1. Question no. 1 has seven sub parts and students need to answer any four. Each sub part carries three and half Marks.

2. Question no. 2 to 5 have three sub parts and students need to answer any two sub parts of each question. Each sub part carries seven marks.

Question No. 1. (4X3.5=14)

a) Show that at fixed T, P and N, the phase transition is followed by minimization of Gibb's free energy.

b) Consider the Gibb's free energy G(m,T) for magnets. Taylor expand it around m=0. Compare it with corresponding G(m,T) obtained by Bragg-Williams method to get G(0,T), coefficient of m^2 and m^4.

c) Consider 1d ring having N spins. Write the Hamiltonian if the exchange interaction is J and external magnetic field is h. Find the transfer matrix P using the symmetrical form of its partition function. Find the partition function for this in thermodynamic limit for h=0.

d) State the basic assumptions of Kinetic theory. Write down the differential form of Boltzmann's equation.

e) Define time and space correlation functions of any quantity A(r,t). Discuss the physical significance of these correlations.

f) Find Liouville's equation for a Hamiltonian system.

g) Define effusion. Draw mean square displacement with time at a finite temperature for 1d diffusion case.

Question No. 2. (2X7=14)

a) Start with ideal gas equation of state and provide reasoning for corrections to it to get a corresponding real gas van der Waals equation of state. Deduce the scaled form of van der Waals equation.

b) Consider a magnet at fixed temperature T and external magnetic field h. Use Weiss mean field theory to get transcendental equation for magnetization m. Analyze the graphical solution of this at T=0 and a nonzero H_1. Specify the stable, metastable or unstable states.

c) For a 1d Ising model use RG approach to get RG flow equations.

Question No. 3. (2X7=14)

a) Consider Boltzmann's transport equation and show that in equilibrium the solution of this is Maxwell-Boltzmann distribution. Further, consider 1d velocity distribution: $f(v_x) = Ae^{-mv_x^2/2kT}$, find the normalization constant A and further find $\langle v^2 \rangle$.

b) Consider a dilute gas in equilibrium at a temperature T in a container. Using kinetic theory and Boltzmann's transport equation find the number of particles per unit volume and per unit time in terms of total scattering cross-section σ_{tot}, temperature T and number density n.

c) What do you understand by following :

(i) Boltzmann's entropy

(ii) Assumption of "Molecular Chaos"

(iii) Ergodicity

Question No. 4. (2X7=14)

a) The solution of 1d Langevin equation can be given as $v(t) = v(0)e^{-\frac{\zeta t}{m}} + \frac{\int_0^t ds e^{\frac{\zeta(t-s)}{m}} F(s)}{m}$. Find $\langle v^2(t) \rangle$ and thus derive the fluctuation-dissipation relation.

b) Consider a Brownian particle in the potential $U(x) = \frac{1}{2}kx^2$. Write the corresponding Fokker-Planck equation in this context. Discuss the functional form of its equilibrium solution.

c) Write brief notes on followings:

(1) Linear response theory.

(2) Kubo formula.

Question No. 5. (2X7=14)

a) Define mean free path and explain collisionless and hydrodynamic regimes. Further define viscosity and Reynolds number.

b) Consider diffusion of particles in d=1. Write down the diffusion equation for the distribution function n(x,t). Show that $n(x,t) = \frac{N}{\sqrt{4\pi Dt}} e^{-x^2/4Dt}$ is a solution of this equation. Plot n(x,t) for t=0 and discuss the behavior this function as t increases. Here, N is the total number of particles.

c) Explain the terms "self diffusion" and "mutual diffusion". Discuss and find the mass and momentum conservation equations using Boltzmann transport equation.

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Jant-Pali, Mahendergarh, Haryana
Term End Examination December-2018

Name of Programme	:	M.Sc. Physics
Year & Semester	:	December 2018, Third Semester (Regular)
Course Name	:	General Theory of Relativity
Course Code	:	SPMS PHY 01 306 DCEC 3104
Maximum Marks	:	70
Duration	:	3Hrs

Note:
(1) All Questions are compulsory. .
(2) Attempt any Four parts in Question No. 1, each part carries 3.5 marks.
(3) Attempt any two parts from each of the questions 2 to 5. Every part carries 7 marks.

Q1
a)Why do we need to parallel transport a vector in order to find its derivative. Define the covariant derivative of a tensor.
b) Define the weak and strong equivalence principles.
c) Describe the phenomenon of bending of light in gravitational field.
d). What is Schwarzschild radius ? Define a black hole and its event horizon in terms of its Schwarzschild radius.
e). Show that the Einstein equations can be written as $R_{\mu\nu} = -\kappa[T_{\mu\nu} - \frac{1}{2}g_{\mu\nu}T]$
f). Prove that the spacetime volume $d^4x = dt\ d^3x$ is a Lorentz invariant quantity.
g). Consider a scalar quantity ϕ. Show that, while the quantity $(\frac{\partial\phi}{\partial x^a})$ is a vector, the quantity $(\frac{\partial^2\phi}{\partial x^a \partial x^b})$ is not a tensor.

Q2. Establish the following identities for a general metric tensor $g_{\mu\nu}$:
a) $g^{\mu\nu}\Gamma^{\alpha}_{\mu\nu} = -(1/\sqrt{-g})(\sqrt{-g}g^{\alpha\beta})_{,\beta}$
b) $(g^{\mu\nu}g_{\nu\alpha,\beta}) = -(g^{\mu\nu}{}_{,\beta}g_{\nu\alpha})$
c) $g^{\mu\nu}_{,\alpha} = -(g^{\beta\nu}\Gamma^{\mu}_{\alpha\beta} + g^{\mu\beta}\Gamma^{\nu}_{\alpha\beta})$

Q3.
a). Derive geodesic equation of motion of a particle in the presence of gravitation.
b). Derive the expression $g_{00} = 1 + 2\phi$ in the newtonian approximation of geodesic equation.
c). Define Kruskal coordinates. What are the advantages of using Kruskal coordinates over Schwarzschild metric tensor.

Q4.
Consider the following line element that describes a spherically symmetric spacetime :
$ds^2 = (1 - \frac{2GM}{r})dt^2 - (1 - \frac{2GM}{r})^{-1}dr^2 - r^2(d\theta^2 + sin^2\theta d\phi^2).$

(a) Is this the most general line element in a spherically symmetric space time ? Elaborateyour claims.

(b) Give dynamical arguments to show that the orbit r = 3G M is unstable, whereas r = 6G Mis stable.

(c) Describe at least two experimental methods for verification of General Theory of Relativity!

Q5

(a). For a scalar field with Lagrangian density $L = \frac{1}{2}\phi_{,i}\phi_{,k}g^{ik}$ derive the energy-momentum tensor.

(b). Show that, if the Lagrangian density L of a field explicitly depends on g_{ik} and $g_{ik,l}$, then the corresponding energy tensor is given by

$$T^{ik} = 2[(\frac{\partial L}{\partial g_{ik,l}})_{,l} + \frac{1}{2}\frac{\partial L}{\partial g_{ik,l}}g^{mn}g_{mn,l} - \frac{\partial L}{\partial g_{ik}} - \frac{1}{2}Lg^{ik}]$$

(c). Dust of density $\rho(t)$ and radiation of density $u(t)$ fill the spacetime given by the line element

$ds^2 = dt^2 - S^2(t)[\frac{dr^2}{1-kr^2} + r^2(d\theta^2 + sin^2\theta d\phi^2)]$ where $k = 1, 0$ or -1. From the conservation law deduce that $\frac{1}{S^3}\frac{\partial}{\partial t}(\rho S^3) + \frac{1}{S^4}\frac{\partial}{\partial t}(uS^4) = 0$.

Given that

h=c=G=1 unless otherwise specified;

$\Gamma^{\alpha}_{\mu\nu} = \frac{1}{2}g^{\alpha\beta}(g_{\beta\mu,\nu} + g_{\beta\nu,\mu} - g_{\mu\nu,\beta})$;

$R^{a}_{bcd} = \partial_c\Gamma^{a}_{bd} - \partial_d\Gamma^{a}_{bc} + \Gamma^{e}_{bd}\Gamma^{a}_{ec} - \Gamma^{e}_{bc}\Gamma^{a}_{ed}$;

$R_{ab} = R^{c}_{acb}$;

$R = g^{ab}R_{ab}$;

CENTRAL UNIVERSITY OF HARYANA

End Semester Examinations Dec 2018

Programme: M.Sc. Physics | **Session:** 2018-19

Semester: III (REGULAR) | **Max. Time:** 3 Hours

Course Title: Physics of Nanomaterials | **Max. Marks:** 70

Course Code: SPMS PHY 01 304 DCEC 3104

Instructions:

1. Question no. 1 has seven parts and students need to answer any four. Each part carries three and half Marks.

2. Question no. 2 to 5 have three parts each and student needs to answer any two parts of each question. Each part carries seven marks.

(4X3.5=14)

Q 1.

a) What is Moor's law? How does the melting point depend on the size of the nanoparticles.

b) What is Quantum Confinement? How it affects the energy level of a material?

c) Explain the reasons for shift in Photoluminescence peaks.

d) Determine the particle size using Scherrer's formula, given:

$$\beta = 0.113° \; and \; 2\theta = 27.152°$$

e) Explain the principle of Transmission Electron Microscopy (TEM).

f) What are the key issues in the synthesis of nanomaterials.

g) What are CNTs? Explain the use of CNTs as chemical sensors.

(2X7=14)

Q 2.

a) Write a detailed note on the band structure of insulators, semiconductors and conductors.

b) Discuss in detail about density of states. Also explain the variation of density of states with energy and size of crystal.

c) Write a note on Nanoscience and Nanotechnology. Discuss the size dependent properties of nanoparticles.

(2X7=14)

Q3.

a) What are Quantum wells? Derive an expression for the energy states of a particle in a Quantum well.

b) What is a Quantum dot (or nanoparticle)? In how many dimensions it is confined? Write down and solve the Schrodinger equation for it and obtain an expression for the energy eigen values.

c) Estimate the first three energies (n=1, 2, 3) for an electron in GaAs quantum wells of width 10nm and 4 nm. Assume the mass to be 0.067 m_o, where m_o is free electron mass. Assume the electron to be confined within one-dimensional infinite potential (i.e. 1D box).

(2X7=14)

Q 4.

a) Differentiate between top down and bottom up approaches. Explain the Ball Milling method for the synthesis of Nanomaterials.

b) Describe:

1. Applications of CNTs
2. Properties of CNTs

c) Explain in detail the Laser Ablation method for the synthesis of CNTs.

Q 5. (2X7=14)

a) What do you understand by scanning probe microscopy (SPM)? How images are formed in a scanning probe microscope? What are the two modes of operation of SPMs?

b) What is Atomic Force Microscopy (AFM)? What are the various modes of operation of an AFM? Discuss about the possible applications of AFM.

c) Explain the principle, construction and working of Scanning Electron Microscopy (SEM).

CENTRAL UNIVERSITY OF HARYANA

End Semester Examinations Dec 2018

Programme: M. Sc. Physics **Session: 2018-19**

Semester: III[rd] **Max. Time: 3 Hours**

Course Title: Atomic, Molecular Physics and Laser **Max. Marks: 70**

Course Code: SPMS PHY 01 301 CC 3104

Instructions:

1. Question no. 1 has seven parts and students need to answer any four. Each part carries three and half Marks.

2. Question no. 2 to 5 have three parts and student need to answer any two parts of each question. Each part carries seven marks.

Q 1. (4X3.5=14)

a) Consider the scattering of an α-particle of energy 10 MeV by an atomic electron, assumed to be initially at rest. What is the maximum momentum that can be transferred to the atomic electron?

b) Calculate $\langle(r^2)\rangle$ for the state $2p_0$ given

$$\psi_{210}(r,\theta,\phi) = \frac{1}{4\sqrt{2\pi}}\left(\frac{Z}{a_0}\right)^{3/2}\left(\frac{Zr}{a_0}\right)e^{-Zr/2a_0}\cos\theta$$

c) Show that in linear Stark Effect the n=3 level of a Hydrogen atom is split into five equally spaced components.

d) Find the fine structure energy shift due to relativistic correction for the 3s state.

e) In the Raman spectrum of ethylene (gas), observed by using 435.8 nm Hg incident radiation, one band appears at 511 nm. Calculate the wavenumber of the vibrational band.

f) Using the Harmonic Oscillator concept calculate the zero-point vibrational energy of HCl given that the force constant of HCl is 516 Nm^{-1}.

g) Consider a 2-level system with E_1=-13.6eV, E_2=-3.4 eV and Einstein coefficient $A_{21}\sim 6\times10^8$ sec^{-1}. What is the wavelength of the light emitted due to transition from E_2 to E_1. Assuming the emission to have only natural broadening, what is the full width at half maxima of the emission spectra. What is the population ratio N_2/N_1 at T=300 K.

Q 2. (2X7=14)

a) Discuss the concept of the spinning electron as a magnetic dipole and hence derive the expression for Larmor frequency

b) What were the main differences between Bohr's atomic model and Rutherford's atomic model. Describe the Bohr's model of Hydrogen atom and show that the atomic spectra can be obtained from it.

c) Derive the expression for the relativistic energy shift due to the Darwin term.

Q3. (2X7=14)

a) Discuss the Paschen-Back effect in detail.

b) Describe briefly fine-structure splitting of an atom and calculate the energy difference between the j=5/2 and j=3/2 level for n=3 due to fine structure splitting.

c) What is Hyperfine structure of an atom. Derive the expression for the Hyperfine energy shift due to magnetic dipole moment.

Q 4. (2X7=14)

a) Derive the rotational energy levels of a symmetric top molecule for a non-rigid rotator.

b) What are infra-red spectroscopy techniques? Explain Working of a double beam spectrometer.

c) Discuss the pure rotational Raman spectra for linear molecules.

Q 5. (2X7=14)

a) Obtain the condition for population inversion and hence derive the expression for the minimum pumping rate below which there will be no LASER action.

b) Define LASER and its basic components. What do you mean by longitudinal and transverse modes in a laser cavity? Explain the methods to select longitudinal and transverse mode for higher irradiant laser.

c) Explain the principle, construction and working of He-Ne LASER.

CENTRAL UNIVERSITY OF HARYANA
Jant-Pali, Mahendergarh, Haryana
Term End Examination December-2018

Name of Programme	:	M.Sc. Physics
Year & Semester	:	December 2018, Third Semester (Regular)
Course Name	:	Nuclear and Particle Physics
Course Code	:	SPMS PHY 01 302 CC 3104
Maximum Marks	:	70 Duration : 3Hrs

Note: (1) All Questions are compulsory.
(2) Attempt any Four parts in Question No. 1, each part carries 3.5 marks.
(3) Attempt any two parts from Question 2 to 5. Each part carries 7 marks.

Q1.
a) What do you understand by nuclear isomerism ?

b) Using square well potential, describe the filling of nucleons using shell model.

c) Caluclate the radii for $^{118}_{54}Xe$ and $^{50}_{20}Ca$ using RR and PP parameterization.

d) Write a short note on SU(2) symmetry.

e) "Positive scattering indicate that nucleus is bounded". Comment.

f) Define magnetic moment of a nucleus? Why does neutron have non zero value of magnetic moment despite zero charge.

g) What are the salient features of liquid drop model ?

Q2.
a) Derive an expression of scattering cross section for low energy np scattering.

b) Show that nuclear forces are tensorial in nature.

c) Starting from 3-Dimensional Schrodinger equation and assuming the potential to be central in nature, find the numerical value for the depth of the potential well for a deuteron. Binding Energy of a dueteron is 2.25 MeV.

Q3
a) Describe Wu's experiment to explain beta decay.

b) List the properties of neutrino. Also explain the indirect method of neutrino detection.

c) Explain nuclear disintegration. Draw decay chain for uranium nucleus.

Q4.
a) Taking LS coupling into account, explain the filling up of proton up to magic number 82.

b) Describe the Fermi Gas model of the nucleus. How does this model fail to describe nucleus properties ?

c) Derive an expression for the wave function of even even nuclei.

Q5.

a) What do you understand by elementary particles ? Classify the elementry particles in different categories.

b) Construct a meson octet using eight fold way (i.e. SU3 symmetry).

c) What are quarks ? Describe quark quantum numbers and their properties. Using conservation laws describe whether the following processes are feasible or not

(i) $p + n \rightarrow p + \mu^+ + \mu^-$

(ii) $p + n \rightarrow p + n + p + \bar{p}$

(iii) $n \rightarrow p^+ + e^-$

CENTRAL UNIVERSITY OF HARYANA

Term End Examinations, Dec 2018

Programme: M.Sc. (Physics) **Session: 2018-19**

Semester: III **Max. Time: 3 Hours**

Course Title: Solid State Physics **Max. Marks: 70**

Course Code: SPMS PHY 01 303 CC 3104

Instructions:

1. Question no. 1 has seven sub parts and students need to answer any four. Each sub part carries three and half Marks.

2. Question no. 2 to 5 have three sub parts and students need to answer any two sub parts of each question. Each sub part carries seven marks.

Question No. 1. (4X3.5=14)

a) The atom He^3 has spin ½ and is a fermion. The density of liquid He^3 is 0.081 gm cm^{-3} near absolute zero. Calculate the Fermi energy and Fermi temperature.

b) What is isotope effect in superconductor? Explain

c) Discuss the term "Brillouin zones"?

d) For copper, the lattice specific heat at low temperature has the behavior of $4.6 \times 10^{-2} \times T^3$ J $kmol^{-1}$ K^{-1}. Estimate the Debye temperature for copper.

e) What are Miller indices? Discuss.

f) Explain the term flux quantum.

g) Differentiate between N-process and U-process.

Question No. 2.

a) Define geometrical structure factor. How is it related to atomic scattering factor? Derive an express for the scattering amplitude in the terms of geometrical structure factor. Show that (2, 2, 2) is an allowed reflection for b.c.c. lattice. (7)

b) (i) Show that reciprocal lattice of a body centered cubic is a face centered cubic. (4)
(ii) An X-ray beam of wavelength 0.97 Å is obtained in third order reflection at 60° from the crystal plane. Another beam is obtained in the first order after reflection at 30° from the same crystal plane. Find the wavelength of the second order. (3)

c) What are Laue equations for diffraction of X-rays by a crystalline solid? Show that Bragg's equation is a special case of the Laue equations. (7)

Question No. 3.

a) Obtain the dispersion relation for a liner diatomic lattice and describe its optical and acoustical modes. Interpret the solution obtained at the zone boundary. Show that higher frequency behavior of optical branch depends upon lighter mass. (7)

b) What is phonon? Give its properties. Explain the term phonon momentum. Give the selection rules for wave-vectors and momentum of phonons. (7)

c) How does Debye model differ from Einstein model? Mention essential differences in the model and note the consequences of these differences. (7)

Question No. 4.

a) Using the free electron gas model obtain the relation for its heat capacity. (7)

b) Explain the tight binding method and its application to simple cubic structure. (7)

c) Describe the nearly free electron gas model. (7)

Question No. 5.

a) (i) Discuss the Josephson effect. Show that a dc current will flow across the Josephson junction with no applied voltage through them. (7)

b) Describe the crystal structure of $YBa_2Cu_3O_{6.93}$ and answer the following questions (7)

(i) Which type of crystal structure is this?

(ii) How many CuO_2 planes in it?

(iii) Mention the variation of coherence length in ab-plane and c-direction

(iv) Nature of Fermi velocity

(v) Variation of critical magnetic field in ab-plane and c-direction.

(vi) What concentration of O, Y-123 has maximum T_c?

(vii) Which layer is charge reservoir?

c) Write the short notes on (3.5+3.5)

(i) Cooper Pair

(ii) Ginzburg-Landau parameter.