UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: I (Solid State Physics-II)

TIME ALLOWED: 3 hrs.
MAX. MARKS: 50

NOTE: Attempt any FOUR questions, in all by selecting at least ONE question from each section.

Section -1

Q.1 (a) What are significances of Hall coefficient? (2.5)

(b) Consider free electron gas in in 3- dimensions, using periodic boundary conditions derive expressions for Fermi energy and density of state for this system. (10)

Q.2 (a) State Wiedman Franz law and also write down the expression for Lorentz number. (2.5)

(b) Explain the factors in detail which can affect the resistivity of electrical materials. (6)

(c) Keeping in mind the central equation determine analytically the splitting of energy levels of free electron in a crystal near the zone boundary. (4)

Q.3 (a) Show that the effective mass of an electron in a crystal depends on the curvature of energy band. Discuss the physical basis for the effective mass of an electron in a crystal. (6.5)

(b) Plot the distribution of probability ρ in the lattice for ψ^{-2} and ψ^{+2} and for a pure travelling wave. (3)

(c) What is cyclotron resonance and how it can be measured experimentally. (3)

Q.4 Describe the quantum theory of paramagnetic susceptibility of a substance in a central magnetic field B_z under the following conditions. (12.5)

i. B_z is weak and temperature is high.

ii. B_z is strong and temperature is low.

Section-11

Q.5 (a) How the conductivity of a semiconductor is affected by doping? Show that the Fermi energy level in the band picture of a semiconductor shifts either towards the conduction band edge or the valence band edge depending on the type of doping? (7)

(b) Derive an expression for intrinsic carrier concentration in a semiconductor. (5.5)

Q.6 (a) Write down an equation for charge density ρ (x) due to impurities and current carriers in a p-n junction. State the meaning of terms used. (4)

(b) Use the equation in part-a to write down the poison's equation for the regions inside the depletion layer. Hence derive a formula for the width of the depletion layer on the n-side (dn) or the p-side (dp). (8.5.j.oh)

.7 Write notes on the following.

(a) Origin of energy gap (6.5)

(b) Donor and Acceptor states (6)

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics **TIME ALLOWED: 3 hrs.**
PAPER: II (Statistical Physics) **MAX. MARKS: 50**

Section-I

NOTE: Attempt any FOUR questions in all by selecting at least ONE question from each section. Try to be focused and give only precise answers to the questions.

Q.1.

(a) State and prove the theorem giving information about the construction of an ensemble by applying the equation of continuity on phase space. (5.5)

(b) Starting with the formula for ensemble averages, obtain the condition for a system in equilibrium. Hence show that a system in equilibrium moves on a surface on constant *P*. (4)

(c) When the sun is directly overhead, the thermal energy incident on the earth is 1.4 kWm^{-2}. Assuming that the sun behaves like a perfect blackbody of radius 7×10^5 km, which is 1.5×10^8 km from the earth, show that the total intensity of radiation emitted from the sun is 6.4×10^7 Wm^{-2} and hence estimate the sun's temperature. (3)

Q.2.

(a) Give the definition of entropy in statistical physics. Illustrate with a simple example that entropy is a measure of the "randomness" of a system. State and explain the important properties of entropy implied by its definition in statistical physics. (5)

(b) The mass of the sun is 2×10^{30} kg, its radius is 7×10^8 m and its effective surface temperature is about 5,700 K. Calculate

i. the mass of the sun lost per second by radiation.

ii. the time necessary for the mass of the sun to diminish by 1%. (3.5)

(c) A nuclear bomb at the instant of explosion may be approximated to a blackbody of radius 0.3 m with a surface temperature of 10^7 K. Show that the bomb emits a power of 6.4×10^{20} W. (4)

Q.3.

(a) Distinguish between three kinds of ensembles by stating their respective distribution functions. (3)

(b) Explain with the help of a graph what factors determine the most probable state of the system in a canonical ensemble. (3)

(c) Use the thermodynamic relations to show that for an ideal gas

$$C_P - C_V = R. \quad (3)$$

(d) If the volume of a perfect gas of N atoms is doubled and the energy is being held constant. Find the change of entropy. What is actually meant by this entropy change? Illustrate your answer by providing necessary physical interpretation? (3.5)

PTO

Q.4.

Write a short note on each of the following: (6, 6.5)

i. Dulong-Petit's law

ii. Fully degenerate Fermi-Dirac gas

Section-II

Q.5.

(a) State the principle of equi-partition of energy. Derive the formula for the specific heat of a system possessing f degree of freedom on the basis of this principle. (4)

(b) Describe qualitatively, how does the formula derived in the above part fail to account for the specific heat of a diatomic gas? What new approach was required to overcome this difficulty? Draw a graph showing the variation of specific heat of diatomic gas with temperature to illustrate your argument. (4.5)

(c) A gas consists of N atoms in thermal equilibrium at temperature T. Each atom can exist in two states of energies: 0 and $\in$. Find the following quantities:

i. The probability that a given atom will be found in the excited state, $\in$.

ii. The entropy of the entire collection. (4)

Q.6.

(a) Describe Maxwell-Boltzmann, Fermi-Dirac, and Bose-Einstein statistics and distinguish between them, especially from the point of view of Pauli's exclusion principle and the in-distinguishability of identical particles. (4)

(b) N particles are distributed among three states having energies 0, KT and 2 KT. If the total equilibrium energy of the system is 1000 KT, what is the value of N? (4.5)

(c) Suppose that in some samples, the density of states of electrons $D(\in)$ is constant i.e. $D(\in)=D_o$ for $\in > 0$. The total number of electrons is N.

i. Calculate the chemical potential, μ at 0K.

ii. For non-zero temperatures, describe the condition that system is non-degenerate. (4)

Q.7.

(a) Obtain the equation, $Tds = C_p dT - T V\alpha dp$

(b) Calculate the solar constant: that is the radiation power received by 1 m^2 of earth's surface. (Assume the sun's radius $R_s = 7 \times 10^8$ m, the earth-sun distance is, $r = 1.5 \times 10^{11}$ m, the earth's radius $R_E = 6.4 \times 10^6$ m, sun's surface temperature, $T_s = 5{,}800$ K and Stefan-Boltzmann constant is $\sigma = 5.7\times10^{-8}$ W/m^2-K^4.

(c) Planck's formula for the blackbody radiation is

$$u_\lambda \, d\lambda = \frac{8\pi hc}{\lambda^5} \frac{1}{e^{\frac{hc}{\lambda kT}}-1} \, d\lambda$$

i. Show that for long wavelengths and high temperatures, it reduces to Rayleigh-Jean's law.

ii. Show that for short wavelengths, it reduces to Wien's distribution law. (4,4,4.5)

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: III (Relativity & Cosmology)

TIME ALLOWED: 3 hrs.
MAX. MARKS: 50

NOTE: Attempt FOUR questions selecting at least ONE from each section.

Section-I

Q1.(a) State the principle of Special Relativity and discuss how it is modified for the framework of General Relativity? [2]

(b) Show that the D'Alembertian operator of Minkowski space $\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}-\frac{1}{c^2}\frac{\partial^2}{\partial t^2}$ is invariant under Lorentz transformation. [7½]

(c) Use the composition law for velocities to prove that if $0<V_{AB}<1$ and $0<V_{BC}<1$ then $0<V_{AC}<1$. [3]

Q2.(a) In a frame S, two events occur at the origin and a distance X along the $x-$axis simultaneously at $t=0$. The time interval between the events in S' is T. Show that the spatial distance between the events in S' is $\left(X^2+Y^2\right)^{1/2}$ and determine the relative velocity v of the frames in terms of X and T. [6]

(b) A particle of rest mass m_Λ decays into a proton of rest mass m_p and a negatively charged π-meson of rest mass m_π. Assuming that the particle Λ is at rest at the time of decay, calculate the total energy of the proton and the pion. [6 ½]

Q3.(a) Starting from the electromagnetic field tensor, find covariant form of four Maxwell equations. [10 ½]

(b) Show that the four force and four velocity vectors are orthogonal to each other. [2]

Section-II

Q4. (a) Use variational principle to derive the equation of geodesic on a manifold. [7½]

(b) Show that the Christoffell symbols $\Gamma^{\lambda}_{\mu\gamma}$ does not follow the coordinate transformation law of a $(1,2)$ tensor. [5]

Q5.(a) Show that for curvature tensor $R_{\rho\mu\nu\lambda}=-R_{\lambda\nu\rho\mu}=-R_{\nu\lambda\mu\rho}=R_{\lambda\nu\mu\rho}$ [4½]

(b) Consider polar coordinates (r,θ). Find the covariant derivative $\nabla_a V^b$ of $\underline{V}=r^2\cos\theta\,\hat{e}_r-\sin\theta\,\hat{e}_\theta$. [8]

Q6. (a) Show that the divergence of Ricci tensor is non-zero but divergence of Einstein tensor is zero. [8½]

(b) Using equation of geodesic, describe the spacetime in the following cases:
- (i) Motion with gravity
- (ii) Motion without gravity [4]

Q7.(a) Show that for the gravitational red shift, the frequency shift $\nabla\nu$ is given by

$$\nabla\nu=-\nu\frac{gH}{c^2}$$

where symbols have their usual meaning. [7½]

(b) Discuss Schwarzchild singularity. [3]

(c) Briefly describe the Newton and Einstein's views about the motion of a particle in gravity. [2]

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: IV (Computational Physics)

TIME ALLOWED: 3 hrs.
MAX. MARKS: 50

NOTE: Attempt FOUR questions in all selecting at least ONE from each section.

Section-I

Q.1	Suppose **A** and **B** be 3x3 matrices. Write C^{++} program which reads in entries of the matrices and calculate (i) **12A + 3B**, (ii) **2A x 2 B^t** and (iii) average of the diagonal elements of matrix **B** Write C++ program with function to calculate **f(x)** = **$33x^3$- $2x^2$ – 44x+44** and print values for x and **f(x)**	08 ½ +4
Q.2.	Write C^{++} program to evaluate the integral $\int_1^6 (\frac{3\sqrt{x}+11}{4})dx$ by Weddle's rule (with n=6). Write program to print the following series: $S=\sum_{n=1}^{10}\frac{x^{n/2}}{3}$ where x = 4.	8+4 ½
Q.3.	Find the roots of the equation 12**x** – **cos x** - **16** using simple iterative method using xo = 1.5. Write C++ program to implement the method correct to 2dp. Write C++ program which reads in a value as binary number and converts that number into decimal. Implement your program for 5 iterations.	7+5 ½

Section-II

Q.4. A	The acceleration of a spherical body experiencing air drag is given by **a = g – k v^2** where **k = c π ρ r^2 / 2 m** with the conditions: **g = 9.8 m/sec^2, c=0.46** (drag constant), **ρ= 1.2 kg/m3, r=1m, v=0 m/sec, h= 0.1 sec** and **tmax=2.5sec.** Write MATLAB program to plot and print time, position, velocity and acceleration values. Also draw estimate output graphs with proper curve labels, x & y labels and title.	06 ½ +6
B	Write MATLAB program to determine corresponding compression x and potential energy p values for the given force and springer constant k values. Also find the maximum and sum of p values. force (N): 11, 7, 8, 8.7, 9.2 k(N/m): 4.5, 3.7, 3.3, 3.5, 4.6 Note: $p=\frac{kx^2}{2}$	

PTO

Q.5. (A)	Write MATLAB program for the Decay of Current in a simple RL-circuit using Euler's Method with initial conditions: r=20Ω, L=6H, initial time 0, time step 0.22, maximum time 15.5sec., initial current 8Amp and voltage v=7 volts. Print and plot current against time values. Draw estimate graphs with proper labels. How you can convert the same program for the growth of current in the circuit?	8+4 ½
(B)	Write a program with function to calculate *f(x)*, given by: $f(x) = 4x^3 - 4x^2 + 4x + 4$. Calculate, print and plot values for *x* and *f(x)*. Also find out sum, average, minimum of f(x) values for ten different values of x.	
Q.6. (A)	Write down the MATLAB syntax with example for: dsolve(), sum(), pretty() and stem().	8+ 4 ½
(B)	Write MATLAB program calculate and print area and circumference of a circle. Take radius values from the user.	
Q.7. (A)	A parallel plate capacitor is constructed from two or more parallel conducting plates such that its capacitance C can be computed from the formula $C = (n-1)\,\varepsilon\, A / d$ Where n is number of plates, $\varepsilon = 8.85 \times 10^{-12}$ farad/meter is dielectric constant, A = 20 cm^2 is the area of each plate separated by distance d = 4 mm. Construct a table to print number of plates against capacitance values for a maximum of 10 plates.	8+ 4 ½
(B)	Create a matrix M in MATLAB expression such that M = $\begin{matrix} 1 & 2 & 3 & 4 & 5 & 6 & 7 \\ 13 & 11 & 9 & 7 & 5 & 3 & 1 \\ 1 & 2 & 4 & 8 & 16 & 32 & 64 \end{matrix}$ Sort data in M. Also find the maximum and mean value of M.	

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics **TIME ALLOWED: 3 hrs.**
PAPER: V (Classical Electrodynamics) **MAX. MARKS: 100**

NOTE: Attempt any FIVE questions, at least TWO questions from each section. All questions carry equal marks.

Section-I

Q.1. (a) Three charges are arranged in a linear array. The charge $-2q$ is placed at the origin, and two charges, each of $+q$, are placed at $(0,0,l)$ and $(0,0,-l)$ respectively. Find an expression for the potential $\varphi(r)$ potential which is valid for distances $r \gg l$. 12

(b) Show that the torque $\boldsymbol{\tau}$ acting on the dipole $\boldsymbol{p}$ in an external electric field $\boldsymbol{E}_{ext}$ is given by

$$\boldsymbol{\tau} = \boldsymbol{r} \times [\boldsymbol{p} \cdot \nabla \boldsymbol{E}_{ext}] + \boldsymbol{p} \times \boldsymbol{E}_{ext}$$ 8

Q.2. (a) Find the following expression for the electric field outside of a dielectric medium, where σ_p and ρ_p are polarization charge densities: 14

$$\boldsymbol{E}(\boldsymbol{r}) = \frac{1}{4\pi\epsilon_o}\left[\oint_S \sigma_p \frac{(\boldsymbol{r}-\boldsymbol{r}')}{|\boldsymbol{r}-\boldsymbol{r}'|^3} da' + \int_V \rho_p \frac{(\boldsymbol{r}-\boldsymbol{r}')}{|\boldsymbol{r}-\boldsymbol{r}'|^3} dv'\right]$$

(b) Discuss briefly the method of images in problems involving dielectrics. 6

Q.3. (a) Discuss boundary conditions for the field vectors $\boldsymbol{E}$ and $\boldsymbol{D}$ for an interface between two media. 8

(b) Two parallel conducting plates are separated by the distance d and maintained at the potential difference $\Delta\varphi$. A dielectric slab consisting of dielectric constant K and of uniform thickness t (such that $t < d$) is inserted between the plates. Determine the field vectors E and D in the dielectric and also in the vacuum between the dielectric and one plate. Neglect edge effects due to the finite size of the plates. 12

Q.4. (a) Discuss the concept of electrostatic energy and energy density of an electrostatic field. 17

(b) What is electrostatic energy? 3

Q.5. (a) Discuss briefly the Ohm's law and conductivity. 8

(b) Show that the magnetic dipole moment $\boldsymbol{m}$ can also be expressed as, where I is the current. 12

$$\boldsymbol{m} = \frac{I}{2}\oint_c \boldsymbol{r} \times \boldsymbol{dl}$$

Section-II

Q.6. (a) By using Maxwell's field equations, show the following transverse dispersion relation for a homogeneous, isotropic and nonmagnetic medium with no prescribed charge and current distribution:

$$k = \sqrt{K}\ \omega/c$$ 12

(b) Discuss Faraday's law of electromagnetic induction. 8

Q.7. (a) Discuss briefly the concepts of unpolarized, linearly polarized, circularly polarized and elliptically polarized waves. 12

(b) Show that inclusion of displacement current gives the generalized Ampere's law. 8

Q.8. Discuss in detail the normal reflection of plane EM wave from a conducting plane. 20

Q.9. Discuss briefly only two topics. 10,10

(a) Magnetic susceptibility and permeability (b) p.n. junction laser
(c) Plasma oscillations (d) Ohm's law and conductivity

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: VI (Nuclear Physics)

TIME ALLOWED: 3 hrs.
MAX. MARKS: 100

NOTE: Attempt any FOUR questions selecting at least ONE from each section. All questions carry equal marks. Please read question carefully and answer accordingly.

Section I

Question 1: (15 + 5 + 5 = 25)

(a): Use basic assumptions of liquid-drop model to derive various factors which contribute to the binding energy of the nucleus and obtain semi-empirical mass formula based on these factors.

(b): Which nucleus is more stable ${}^7_3Li$ or ${}^8_3Li$? Given: $m_p = 1.007825$ amu, $m_n = 1.008665$ amu, $m_{Li_7} = 7.016003$ amu and $m_{Li_8} = 8.022486$ amu.

(c): Explain what type of multipole moments exist for nuclei and why?

Question 2: (12 + 13 = 25)

(a): What is the working principle of a Betatron? Also write its construction and working.

(b): Explain in detail principle, working and construction of Scintillation Counter.

Section II

Question 3: (13 + 12 = 25)

(a): In a β-decay process, in the *allowed* approximation, the partial decay rate for electrons and neutrinos with the proper momenta is:

$$d\lambda = Ap^2q^2dp$$

where p and q are momenta of emitted electron (positron) and antineutrino (neutrino), respectively, and A is constant including all factors independent of p and q. Use this expression to calculate momentum, $N(p)$, and energy, $N(T_e)$, distributions of the emitted

(P.T.O.)

electrons. Draw the expected shape of these distributions and also draw the Fermi-Kurie plot.

(b): Using the angular momentum and parity selection rules, explain the multipolarity of gamma rays in a gamma decay process.

Questio 4: (15 + 10 = 25)

(a): What are basic assumptions of the shell model? Discuss use of various choices of nuclear potential to produce magic numbers.

(b): Show that nuclear forces are charge independent and spin dependent.

Section III

Question 5: (10 + 10 + 5 = 25)

(a): Differentiate between exothermic and endothermic reactions. For an endothermic reaction $a + X \rightarrow Y + b$, derive an expression for the threshold energy.

(b): What are direct reactions? When does a process can occur via direct reaction mechanism? Explain why the cross-section of (d,p) reaction is much higher than that of (d,n) reaction at low energy.

(c): Write down the conservation laws in nuclear reactions.

Question 6: (10 + 15 = 25)

(a): Classify neutrons with respect to their energy. List different neutron sources explaining one in detail.

(b): Explain in detail the CNO and P-P fusion cycles through which Hydrogen is being converted to Helium in Sun.

Question 7: (10 + 15 = 25)

(a): Differentiate between fission and fusion reactions giving examples.

(b): Define fission chain reaction. Discuss in detail the difficulties involved in sustaining a fission chain reaction. What are their possible solutions?

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: VII (Solid State Physics-I)

TIME ALLOWED: 3 hrs.
MAX. MARKS: 100

NOTE: Attempt any FOUR questions. All questions carry equal marks.

1. (a) Differentiate very comprehensively the assumptions made for Nearly free electron model and tight binding approximation (TBA). 6

   (b) Evaluate the expression for Eigen energy of electrons using nearest neighbor interactions following Tight Binding Approximation. Also apply the energy expression to a simple cubic lattice and explain the results. 12+7

2. (a) Write in detail about the concept of Pseudopotential? Draw the hard and soft crystal potential. 8+2

   (b) Explain the Orthogonalized plane wave method (OPW). Define the term effective potential (or Pseudopotential) and describe why it is weak as compared to the true potential. 10+5

3. (a) What do you understand by Causality? Give an example. Derive the two Kramers-Kronig relations for a linear passive system of harmonic Oscillators? 2+13

   (b) Differentiate between direct and indirect gap materials and between Inter- and Intra-band electronic transitions. 5+5

4. (a) How do you differentiate between Displacive and order disorder ferroelectrics? Explain very comprehensively the phenomenon of polarization catastrophe with regards to displacive ferroelectrics. 4+10

   (b) What is polarizability? Give a comprehensive description of three different sources of polarizability in a material. Also draw polarizability against frequency and label it appropriately to mark three different polarizabilities. 1 ½ +8+ 1 ½

5. (a) What do you understand by Born-Oppenheimer Approximation for solid state problems? How does it lead to separate equations for nuclear and electronic motion? 10

   (b) What is independent electron approximation? Derive Hartree equations using variational principle. Why Hartree product does not suit for description of electrons? 2+10+3

6. (a) Describe comprehensively the phenomenon of flux quantization in a superconducting ring and evaluate the expression for fluxoid. 10

   (b) What are type I superconductors? Describe with the help of diagram. Describe free energy and heat capacity for normal and superconducting phases of a type I superconductors to understand thermodynamics. Draw the heat capacity for both normal and superconducting phases against temperature. What information does it give about energy of electrons? 2+ 10+ 3

7. Write note on any two of the following 12½ , 12½
   (a) AC Josephson effect in superconductors
   (b) Energy loss of fast moving particles in solids
   (c) Wannier Mott excitons

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: VIII (Solid State Physics-II)

TIME ALLOWED: 3 hrs.
MAX. MARKS: 100

NOTE: Attempt any FOUR questions. All questions carry equal marks.

Q.1 (a) What are ionic crystals? Deduce Madelung energy term from the total lattice energy.
(b) Explain the details of microscopic theory of frequency dependent dielectric constant. **(12.5+12.5)**

Q.2 (a) Derive and graphically illustrate Curie-Weiss law.
(b) How does the saturation magnetization vary at different temperatures? Also elaborate its behavior at absolute zero. **(5+20)**

Q.3 (a) Discuss the Hamiltonian of electron-phonon interactions.
(b) What are the reasons behind the stability of the ferromagnetic domains? **(12.5+12.5)**

Q.4 (a) Explain various optical properties of a typical semiconductor.
(b) Find the dispersion relation for the quantized spin waves **(10+15)**

Q.5 (a) What is phonon? Explain the screening of electron-phonon interactions.
(b) What is Hubbard model? How it can be used to differentiate the metallic and insulating limits. **(12.5+12.5)**

Q.6 (a) Show that the measured Hall resistance becomes quantized at extremely low temperatures and high magnetic fields.
(b) How does the ferromagnetic resonance frequency modify due to shape of the specimen? **(12.5+12.5)**

Q.7 Write note on any two of the followings:
(a) Neutron Magnetic Scattering
(b) Geomagnetism and Biomagnetism
(c) Electron Paramagnetic Resonance **(12.5+12.5)**

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: XIII (opt-iv) [Advance Electronics]

TIME ALLOWED: 3 hrs.
MAX. MARKS: 100

NOTE: Attempt any FIVE questions, All questions carry equal marks.

Q.1 a) Describe the working of Solar Cell and Photo Conductor. 12,8

b) Compute the output voltage for the Inverting OP-Amp, if R_f= 7.5 KΩ, R_i= 1.5KΩ, and V_{in} = 24mv.

Q.2 a) A differential amplifier has a differential gain A_d =100. The input voltages are V_1=1mV And V_2 = 0.9mV. Calculate the output voltage for CMRR =1000. 6,14

b) Draw the Combinational logic circuit for the Excess-3 to BCD code converter.

Q.3 a) Define the Multiplexer and De-Multiplexer. Draw the logic circuit for 8*1 Multiplexer. 12,8

b) Explain the working of D-type Master Slave Flip-Flop.

Q.4 a) What is D to A and A to D . Explain the working of R-2R Ladder network. 12,8

b) Determine the output Voltage for Binary Weighted summing amplifier, if the following input Voltages are applied. V_1=1V, V_2=0V, V_3=1V, V_4=1V.

where R_1=R_f, R_2=R_f/2, R_3= R_f/4, R_4= R_f/8.

Q.5 a) Explain the difference between the A-Synchronous and Synchronous. 5,15

b) Design a Synchronous Up-Counter of Mod- 11 with D- type Flip-Flops.

Q.6 a) What is the difference between the Modulation and D-Modulation? 5,15

b) What are the types of Modulation? Draw the Radio Broadcasting Transmitter?

Q.7 a) Discuss the working of Microprocessor system. 12,8

b) Discuss the Properties of Microwave.

Q.8 a) Describe the construction, working and Characteristics of the Magnetron tube. 20

Q.9 Write the note any two of the following 10,10

i) PLD's

ii) RAM and ROM

iii) Shift Registers

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics **TIME ALLOWED: 3 hrs.**
PAPER: IX (Particle Physics-I) **MAX. MARKS: 100**

NOTE: Attempt any FOUR questions selecting at least ONE from each section. All questions carry equal marks. Please read question carefully and answer accordingly.

Section I

Question 1: $(13 + 10 + 2 = 25)$

(a): Discuss the various types of interactions among elementary particles giving their characteristic coupling constant, lifetimes, ranges and mediating field particles. Draw the primitive vertices and also give one representative example for each interaction.

(b): Explain strangeness-changing weak interactions with the help of examples. How theory of weak interactions can be modified in order to account such processes.

(c): Draw a Feynman diagram showing the mechanism for μ^--decay.

Question 2: $(12 + 8 + 5 = 25)$

(a): Make a table for the charge (Q), strangeness (s) and isospin (I_3) for the three quarks up, down and strange. Use these values to find the values of Q, s and I_3 of different states of delta (Δ) particle, proton (p), omega (Ω^-) and different states of pion (π). Also write down quark content of these hadrons.

(b): Show that the translational symmetry in Quantum mechanics leads to the conservation of linear momentum.

(c): How is it possible that same combination of quarks can go to make a no of different hadrons. Explain it with the help of examples.

Section II

Question 3: $(10 + 8 + 7 = 25)$

(a): Define G-symmetry operation and G parity. Show that G-parity of $\{\pi^+, \pi^-, \pi^0\}$ is equal to -1.

(b): Define SU(2) group. Show that its generators are Pauli-spin matrices.

(c): Show that the induce operator of time reversal is anti-unitary.

Question 4: $(10 + 10 + 5 = 25)$

(a): What are Gauge transformations? Show that using Lorentz gauge the four Maxwell equations are equivalent to the following field equation

$$\Box^2 A^\mu = J^\mu$$

(P.T.O.)

(b): The propagation of electromagnetic waves in free space modify the field equation as

$$\Box^2 A^\mu = 0.$$

Use this equation to discuss polarization states of photon.

(c): Write down the spin states, $|s, m_s>$ of a system of two spin-1/2 particles in terms of the constituent spins. Also comment on the symmetry of these states.

Section III

Question 5: (15 + 10 = 25)

(a): Show that in the presence of a small and transient interaction potential $V = V(x, t)$, the transition rate of a system from an initial state i to final state f is given by

$$W_{fi} = 2\pi |V_{fi}|^2 \rho(E_i)$$

where V_{fi} is matrix element and $\rho(E_i)$ is density of states.

(b): Derive the expression for the current and probability density of the state function satisfying the Klein-Gordan equation. Also find the values of these for plane wave solution.

Question 6: (10 + 10 + 5 = 25)

(a): Show that Schroedinger wave equation is not invariant under Lorentz transformations.

(b): Using relativistic expression of energy, derive Dirac equation in the covariant form. Also derive the adjoint form of the Dirac equation.

(c): Show that $\gamma^\mu\gamma^\nu + \gamma^\nu\gamma^\mu = 2g^{\mu\nu}$.

Question 7: (15 + 10 = 25)

(a): Prove that the following Dirac bilinears

$$\bar{\psi}\psi, \quad \bar{\psi}\gamma^5\psi, \quad \bar{\psi}\gamma^\mu\psi, \quad \bar{\psi}\gamma^\mu\gamma^5\psi$$

are scalar, pseudo-scalar, vector and axial vector, respectively.

(b): Show that in the ultrarelativistic limit, an eigenstate of a helicity operator will also become eigenstate of the chirality operator and vice versa.

UNIVERSITY OF THE PUNJAB

Part-II A/2018
Examination:- M.A./M.Sc.

Roll No. ....

Subject: Physics
PAPER: X (Particle Physics-II)

TIME ALLOWED: 3 hrs.
MAX. MARKS: 100

NOTE: Attempt any FIVE questions selecting at least ONE from each section.

Section I

Q1. List the factors on which crossection of a scattering process depends. By using partial wave formalism show that

$$\sigma = \sum_{l=0}^{\infty} \sigma_l = \frac{4\pi}{k^2} \sum_{l=0}^{\infty} (2l+1) \sin^2 \delta_l \qquad (20)$$

Q2. State and prove optical theorem.

(20)

Q3. Define Mandelstam variables. Show that for electron-positron scattering in s-channel in center of mass frame

$$\begin{aligned} s &= 4\left(k^2 + m^2\right), \\ t &= -2k^2 (1 - \cos\theta), \\ u &= -2k^2 (1 + \cos\theta), \end{aligned}$$

where θ is the center of mass scattering angle and $k = |\mathbf{k}_i| = |\mathbf{k}_f|$, where $\mathbf{k}_i$ and $\mathbf{k}_f$ are the momenta of the incident and scattered electrons.

(20)

Section II

Q4. Discuss quark model in detail. Briefly explain the classification of particles in quark model. Write down two similarities and two differences between quarks and leptons.

(20)

Q5. Write down Maxwell equations in covariant form. Show that E and B fields are unchanged by the gauge transformation

$$A_\mu \to A'_\mu = A_\mu + \partial_\mu \chi \qquad (20)$$

PTO

Q6. Consider a real electron moving in an electromagnetic field A^{μ}. Find out the transition amplitude T_{fi}. Also derive the expression for current density j^{μ}_{fi}. where

$$T_{fi} = -i \int j^{\mu}_{fi} A_{\mu} d^4x \qquad (20)$$

Section III

Q7. By using Feynman rules, write down the expression for the invariant amplitude for electron-muon scattering. Show that for the process $e^+e^- \to \mu^+\mu^-$ the differential crossection is given by

$$\left.\frac{d\sigma}{d\Omega}\right|_{CM} = \frac{\alpha^2}{4s}\left(1+\cos\theta\right)^2 \qquad (20)$$

Q8. For the process $e^-\mu^- \to e^-\mu^-$ in Laboratory frame, justify the following relations

$$\begin{aligned}\int \frac{d^3p'}{2p_0}\delta^{(4)}\left(p+q-p'\right) &= \int d^3p' dp'_0 \delta^{(4)}\left(p+q-p'\right)\theta\left(p'_0\right)\delta\left(p'-M^2\right)\\ &= \frac{1}{2M}\delta\left(\nu+\frac{q^2}{2M}\right)\\ &= \frac{1}{2MA}\delta\left(E'-\frac{E}{A}\right),\end{aligned}$$

where $A = 1 + \frac{2E}{M}\sin^2\frac{\theta}{2}$ and the step function $\theta(x)$ is 1 if $x > 0$ and 0 otherwise. Also $q^2 = -2k.k' = -2EE'(1-\cos\theta)$ and $q^2 = -2p.q = -2\nu M$. Also $\nu = E - E' = -\frac{q^2}{2M}$.

(20)

Q9. Prove the following

1. i. $\mathrm{Tr}(\not{a}\not{b}) = 4a.b$
   ii. $\gamma_{\mu}\not{a}\gamma^{\mu} = -2\not{a}$
   iii. $\gamma_{\mu}\not{a}\not{b}\not{c}\gamma^{\mu} = -2\not{c}\not{b}\not{a}$
   iv. $\mathrm{Tr}(\not{a}\not{b}\not{c}\not{d}) = 4\left[(a.b)(c.d) - (a.c)(b.d) + (a.d)(b.c)\right]$

(5+5+5+5)