M.Sc. Physics Semester-I, 2022-23

Barasat Government College

Mathematical Methods

PHSPCOR1T

Time: 50 minutes **Full Marks: 16**

Notations have their usual meanings.

1. (a) What do you mean by the principal value of an integral. Applying the calculus of residues evaluate $\int_{-\infty}^{\infty} \frac{\sin x}{x} dx$.

(b) Find the roots of the z, where $z^2 = -81$. (2+4)+2

2. (a) Show that if P_1 and P_2 are two projection operators, then (P_1+P_2) will be again a projection operator if and only if P_1 and P_2 are orthogonal operators.

(b) If A and B are two linear operators then show that AB is also a linear operator.

(c) Show that if any two non-null vectors are orthogonal to each other, they will also be linearly independent. 4+2+2

Internal assessment

PG-SEM-1, Physics, Paper-PHSPCOR04T, Date: 06/02/2023: 3:00 PM

FM: 16 Time: 45 Minutes

1) Calculate the second harmonic distortion if an output waveform displayed on an oscilloscope provide the following measurements. (i) $V_{CE(min)}$ = 4V, $V_{CE(max)}$ = 50V, $V_{CE(Q)}$ = 25V (ii) $V_{CE(min)}$ = 8V, $V_{CE(max)}$ = 42V, $V_{CE(Q)}$ = 25V 1.5 + 1.5 = 3

2) What is characteristic impedance? Derive the expression for characteristic impedance of symmetrical π network. Briefly describe the properties of real & imaginary parts of propagation constant. 1 + 3 + 1 = 5

3) Design a constant-k low pass T section filter, having cut-off frequency f_c = 12KHz and load impedance 600Ω. 3

4) In a M-ARY FSK signal the number of bit in a symbol is 8 and bit frequency is 1 KHz. Find the frequency bandwidth of the modulated signal. 2

5) Describe the procedure of generation of DSB-SC AM signal generation with block diagram 3

M.Sc. Physics Semester-II, 2022-23

Barasat Government College

Statistical Mechanics

PHSPCOR08T

Time: 25 minutes **Full Marks: 8**

Answer **any two** questions. **4 × 2 = 8**

1. Show that in canonical ensemble the variance of energy E of a system is $K_B T^2 C_V$, where C_V is the specific heat of the system at constant volume. Hence show that the relative-root-mean-square fluctuation in E is of the order of $N^{-1/2}$, where N is the number of particles of the system. 4

2. Show that the probability of a system in the grand canonical ensemble to be in the energy state E_r with N_s number of particles is $P_{r,s} = \frac{e^{-\beta E_r - \alpha N_s}}{\sum_{r,s} e^{-\beta E_r - \alpha N_s}}$, where $\beta = 1/K_B T, \alpha = -\mu/K_B T$. Here μ is the chemical potential of the system. Hence find the expression for the average energy of the system. 4

3. A classical system consists with N non interacting particles. Each particle can take two energy states 0, ϵ. The energy level ϵ is doubly degenerated. Find the average energy and the specific heat of the system. 2+2

INTERNAL PRACTICAL EXAMINATION – PG – SEMESTER 2– 2021 – (AD sir)

PAPER – General Experiments-Semester-2

Full Marks – 20 *Time – 1 hour*

Attempt any 10 (Ten) questions from the following. All questions carry equal marks.

Full Marks –> 2 x 10 = 20 Marks

(1) Sketch the Optical arrangement of a Michelson Interferometer, illustrating clearly the optical beam path forming the interference fringes.

(2) Why do we need a beam splitter in Michelson Interferometer? Explain the purpose clearly.

(3) Explain the formation of circular fringes by virtue of diverging optical beams in Michelson Interferometer.

(4) What is the condition for constructive and destructive interference to determine the laser wavelength in Michelson Interferometer?

(5) What is the purpose of sodium light and laser in Michelson Interferometer Experimental setup?

(6) In Michelson Interferometer both phenomena of reflection and transmission of beam occurs – True or False? Explain logically.

(7) Sketch the block diagram of the Electron Spin Resonance (ESR) Setup showing all the required components.

(8) (i) Which region of the electromagnetic (EM) waves is used the ESR Setup? (ii) How do we read the EM waves to perform the ESR experiment?

(9) (i) What is DPPH? (ii) Why do we use DPPH in the experimental setup to study ESR?

(10) "Electron Spins do not always act as Paramagnetic centres" – True or False. Explain logically.

(11) Differentiate between the magnetic field at the centre of Helmholtz coil, peak to peak magnetic field and the magnetic resonance frequency in the ESR experiment.

(12) How does resonance condition occur in ESR experiment? Explain with proper reason.

x-----x-----x

M.Sc. Physics Semester-III, 2022-23

Barasat Government College

Elective Statistical Physics

PHSPDSE02T

Time: 25 minutes **Full Marks: 8**

Notations have their usual meanings.

Answer **any two** questions. **4 × 2 = 8**

1. (a) Discuss the nature of the order parameter near the first order and second order transition points.

(b) What is the value of the upper critical dimension d_c of the Ising system? What will be the value of the order parameter exponent β at any dimension $d > d_c$? 2+2

2. Show that $\lim_{\vec{k}\to 0} G(\vec{k}) = \frac{\chi}{\beta V}$, where $G(\vec{k})$ is Fourier transform of the correlation of order parameter fluctuations between two different spatial points and $\beta = 1/K_B T$. Here χ and V are the susceptibility and system volume respectively. 4

3. Expression of the Helmholtz free energy in Landau theory of phase transition is given by

$$F(m,T) = L_2(T)m^2 + L_4 m^4 + L_6 m^6. \;\; L_4 > 0, L_6 > 0 \text{ and } L_2(T) = \widetilde{L_2}(T - T_c), \widetilde{L_2} > 0.$$

Here m is the order parameter. Calculate the order parameter exponent β and susceptibility exponent γ. $2 + 2$

INTERNAL PRACTICAL EXAMINATION – PG – SEMESTER 4 – 2021 – (AD sir)

PAPER – Condensed Matter Physics (Advance II)

Full Marks – 20 *Time – 1 hour*

Attempt any 10 (Ten) questions from the following. All questions carry equal marks.

Full Marks –> 2 x 10 = 20 Marks

(1) Draw the schematic diagram and label the components of the Four Probe Method (FPM) to measure the resistivity of a given semiconductor sample.

(2) What do you understand by the terms G_6 and G_7 correction factors in FPM?

(3) Define the resistivity of a given semiconductor sample in terms of the required correction factors.

(4) What is the expression for resistivity as a function of heater temperature? State the units properly involved in the expression and sketch the nature of the graph of ρ versus T (temperature).

(5) Do you think that heating of the sample or cooling of the sample will change the value of resistivity of the sample? Explain with proper logic.

(6) (i) Why do we need to check for the I-V characteristics of the FPM at room temperature?
(ii) What will happen if I-V readings are recorded continuously with fast heating rate of the Heater coil?

(7) What is the fundamental difference between Magnetoresistance and Hall Effect?

(8) Sketch the experimental arrangements to measure Hall Effect and Magnetoresistance.

(9) What type and range of meters will you be requiring to record the variable parameters involved in the Experiment to observe the phenomenon of Magnetoresistance in the given sample?

(10) How is transverse magnetoresistance different from longitudinal magnetoresistance? Explain with proper circuit diagram.

(11) In the case of lead (Pb), how does the value of magnetoresistance change with the variation in applied magnetic field?

(12) Will there be any difference in magnetoresistance in case of p- type and n-type semiconductors? Explain with proper logic.

x-----x-----x

Internal assessment

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FM: 16 Time: 45 Minutes

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