Total No. of printed pages = 6

3 (SEM 6) PHY M4

2015

PHYSICS

(Major)

Theory Paper : M-6.4

Full Marks – 60

Time – Three hours

The figures in the margin indicate full marks for the questions.

GROUP – A

(Statistical Mechanics)

1. Answer the following questions : 1×5=5

   (a) State ergodic hypothesis. 1

   (b) What type of wave function is required to describe a system of fermions ? 1

   (c) What is the probability of finding an electron with energy equal to the Fermi energy in a metal ? 1

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(d) What is degeneration in statistical mechanics ? 1

(e) What is the basic difference regarding the state of a particle in the phase space between quantum theory and classical theory ? 1

2. Answer the following questions : 2×3=6

(a) Write the expression of most probable distribution in three different statistics. Under what condition F-D and B-E statistics reduce to M.B. statistics ? 2

(b) A system has two particles a and b. Show with the help of diagrams how these two particles can be arranged in three quantum states 1, 2, 3 using (i) M-B (ii) B-E (iii) F-D statistics. 2

(c) An electron gas obeys the M-B statistics. Calculate the average thermal energy (in ev) of an electron in the system at 300 K. 2

3. Answer any *two* of the following : 2×5=10

(a) Derive Boltzmann entropy relation in classical statistics. Under what condition is the maximum entropy reached ? 4+1=5

(b) What is Fermi energy ? Derive an expression of Fermi energy for an electron gas. 1+4=5

(c) Starting from B-E distribution function deduce the planck Radiation formula. 5

4. Answer any *one* of the following : 9

(a) Using B-E statistics, derive an expression of pressure of a perfect gas. Under what condition does Bose-Einstein Condensation occur ? 8+1=9

(b) Derive the expression of most probable distribution in M-B statistics. For what type of particles is this statistics applicable ? 8+1=9

GROUP – B

(Computer Applications)

5. Answer the following questions : 2×2=4

(a) Write down the FORTRAN-95 or C or C++ expression for the algebraic expressions :

(i) $\sin x + 2x^3$

(ii) $\tan^{-1}A$

(b) How are the following mathematical functions written in FORTRAN-95 or C or C++ ?

(i) exponential (base e) of x.

(ii) natural logarithm (base e) of z.

6. Answer the following : 2×3=6

(a) How will you represent the following ? Comment : "This program computes a solution to the equation", in FORTRAN-95 or C or C++.

(b) Write one conditional and one logical operators each in FORTRAN-95 or C or C++.

(c) Write a brief statement to find square root of a natural number N in either FORTRAN-95 or C or C++.

7. Answer either (a) or (b) : 5

(a) Write down the flowchart and a program in either FORTRAN-95 or C or C++ to find the greatest of three given integers x, y and z.

(b) Write down the algorithm and a program in either FORTRAN-95 or C or C++ to find sum of N natural numbers.

8. Answer either (a) or (b) : 5

(a) Write a program in either FORTRAN-95 or C or C++ to compute the solution of the following simultaneous linear equations :

$a_1x + b_1y = c_1$

$a_2x + b_2y = c_2$.

(b) Prepare a program in either FORTRAN-95 or C or C++ to compute the real as well as imaginary roots of the quadratic equation $4x^2 - 2x + 9 = 0$.

9. Answer either (a) or (b) : 10

(a) Write down the steps necessary to compute the numberical solution of a first-order differential equation using 4th order Runge-Kutta method. Develop the algorithm and write the program in either FORTRAN-95 or C or C++ to compute the numerical solution of the equation $\frac{dy}{dx} = 3x + y^2$ in the interval [1, 1.1] having initial value y = 1.2 at x = 1 and step size h = 0.1 using Runge-Kutta 4th order method.

(b) Write the mathematical relations needed to compute numerical value of a finite size integral using Simpson's one-third rule : Write the flowchart and a program in either FORTRAN-95 or C or C++ to compute the numerical value of the integral $\int_0^1 \frac{x^2 dx}{1+x^3}$ using Simpson's one-third rule.