2014

PHYSICS

(Major)

Paper : 6.4

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

Write the answers to the two Groups in separate books

GROUP—A

(Statistical Mechanics)

(*Marks* : 30)

1. Answer the following questions : 1×4=4

(a) How many dimensions of the phase space are required to describe a system of N particles?

(b) Write down the expression for the ensemble average of a physical quantity.

(c) What type of wave functions is required to describe a system of bosons?

(d) What are the occupation numbers of a quantum state for fermions?

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

(a) State the postulate of equal a priori probability.

(b) Write the Boltzmann relation which connects statistical mechanics with thermodynamics. Hence find the entropy of a system at the absolute zero temperature.

(c) The relative probability of finding a system in the energy states E_1 and E_2 is e^2. If $E_2 - E_1 = 4 \cdot 83 \times 10^{-21}$ J, calculate the temperature of the system.

3. Answer any *two* of the following questions :

(a) Establish Liouville's theorem and give its physical interpretation. 4+1=5

(b) Calculate the probability of finding two particles together in any one of three different quantum states if they are (i) classical particles, (ii) bosons and (iii) fermions. 2+2+1=5

(c) Describe the phenomenon of Bose-Einstein condensation. Give one physical example of this phenomenon. 4+1=5

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

(a) Deduce the Maxwell-Boltzmann energy distribution law

$$n(u)\,du = \frac{2\pi N}{(\pi kT)^{3/2}}\, u^{1/2}\, e^{-u/kT}\, du$$

Represent this distribution graphically. 9+1=10

(b) What is the Fermi energy? Find an expression for the Fermi energy using Fermi-Dirac statistics.

Calculate the Fermi energy in copper provided number density of free electrons is $8 \cdot 5 \times 10^{28}$ electrons/m^3. 2+6+2=10

GROUP—B

(Computer Applications)

(*Marks* : 30)

5. Answer the following : 1×4=4

(a) Write down the input and output statements used in either FORTRAN-95 or C or C^{++}.

(b) Write down the FORTRAN-95 or C or C^{++} expression for the algebraic expression $a = x + \frac{y}{z} - r^2 + c^3$.

(c) How the following mathematical functions are invoked in FORTRAN-95 or C or C^{++}?

(i) Absolute value of x

(ii) y to the power z

(d) What is nested loop?

6. Answer the following : 2×3=6

(a) Briefly explain a statement use to implement looping in either FORTRAN-95 or C or C^{++}.

(b) What is an array? Write down the syntax for declaration of a one-dimensional array in either FORTRAN-95 or C or C^{++}.

(c) Write down the FORTRAN-95 or C or C^{++} comparison operator corresponding to mathematical sysmbols (i) =, (ii) $\neq$, (iii) $\geq$ and (iv) $\leq$.

(Continued)

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 sum of the following series :

$$1+3+5+...+25$$

(b) Write down the algorithm and a program in either FORTRAN-95 or C or C^{++} to generate first fifteen numbers of the series

0, 1, 1, 2, 3, 5, 8, ...

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

(a) Prepare a program in either FORTRAN-95 or C or C^{++} to compute the real as well as imaginary roots of the quadratic equation $ax^2 + bx + c = 0$.

(b) Write down the flowchart and a program to compute the approximate value of the real root of the following equation :

$$x^7 - 2x^4 + x - 8 = 0$$

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

(a) Write down the necessary relation to compute the numerical solution of a first-order differential equation using Runge-Kutta fourth order method.

Develop an algorithm and write a program in either FORTRAN-95 or C or C^{++} to compute the numerical solution of the equation

$$\frac{dy}{dx} = \frac{1}{2}(1+x)y^2$$

in the interval [0, 1] having initial value $y = 1$ at $x = 0$ and step size $h = 0 \cdot 1$ using Runge-Kutta fourth order method.

(b) Give the mathematical relations used to compute numerical value of an 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

$$\int_0^1 \frac{dx}{1+x^2}$$

using Simpson's one-third rule.

★ ★ ★