(*Time*: 3 *hrs*) **Total Marks: 100**

N. B.:

(1) **All** questions are **compulsory.**
(2) **Figures** to the **right** indicate **full** marks.
(3) Draw **neat** diagrams wherever **necessary.**
(4) Symbols have usual meaning unless otherwise stated.
(5) Use of **non-programmable** calculator is allowed.

Boltzmann constant $k = 1.38 \times 10^{-23}$ Jk^{-1}, Planks constant $h = 6.63 \times 10^{-34}$ Js

1. Attempt any **two:---**
   (a) Explain in detail summary of method of counting. **10**
   (b) Explain in detail Normal or Gaussian distribution. **10**
   (c) Explain the Poisson distribution and derive the required relations. **10**

2. Attempt any **two:---**
   (a) The motion of the transverse wave on a string is given by **10**
   $\frac{\partial^2\phi}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2\phi}{\partial t^2}$
   Find the general periodic motion solution of the wave equation.
   Also find the solution ϕ (x, t) for the initial conditions given
   ϕ (0, t) = ϕ (L, t) = 0 $\quad \left.\frac{\partial\phi}{\partial t}\right|_{t=0} = 0$
   ϕ (x, 0) = Sin $\frac{n\pi x}{L}$
   (b) Use the method of successive integration to solve **10**
   i) $y'' + 3y' = 10 \sin x$
   ii) $y'' - y' - 2y = 4$
   (c) i) Express cos z in exponential form when z is complex. Hence find the value of $\cos(\pi + i \ln 5)$ **10**
   ii) z = (1+ *i*) e^{it} where z represents the displacement of the particle from the origin . Find the magnitudes of velocity and acceleration.

3. Attempt any **two:---**
   (a) Define partition function. Obtain an expression for translational partition function. Find translational partition function for *Ar* (mass 6.63×10^{-26} kg) confine to a volume of 1 liter at 298 K. **10**
   (b) Explain Boltzmann distribution of energy associated with dominant configuration. Hence find the probability of occupying a given energy level. **10**
   (c) Derive an expression for total energy for two-level system. Determine the total energy of an ensemble consisting of N particles that have only two energy separated by energy hv. **10**

4. Attempt any **two:---**
   (a) Derive Maxwell-Boltzmann distribution law in terms of $\propto$ and β. Evaluate $e^{-\alpha}$ and β. **10**
   (b) What are Fermions? Derive Fermi-Dirac distribution law. Also define occupation index. **10**
   (c) Write Plank's formula for black body radiation, using this obtain Wien's displacement law and Stefan-Boltzmann law. **10**

5. Attempt any **Four:---**

(i) Two students are working separately on the same problem. If the first student has the probability ½ of solving it and the second student has probability ¾ of solving it, what is the probability that at least one of them solve it? **05**

(ii) Write short note on sample space. **05**

(iii) Using the method of separation of variables solve $\frac{\partial^2 u(x,y)}{\partial x\,\partial y} = 0$ **05**

(iv) Find $\ln i$. Hence evaluate i^{-2i} **05**

(v) Write a short note on degeneracy of energy states. **05**

(vi) What is the weight associated with the configuration corresponding to observing 40 heads after flipping a coin 100 times? How does these weights compare to that of the most probable outcome? **05**

(vii) Find the thermodynamic probability of : **05**
a) the most probable and
b) the least probable distribution of 10^6 identical particles among 5×10^5 identical cells.

(viii) Find out the number of possible arrangements of seven particles in ten cells, assuming they obey: **05**
(a) B.E. Statistics and (b) F.D. Statistics.

****

0176B61343BA3FEBBB83E4237C3DD4CF