Prepared by Dr. V. Upadhyaya

Reg. No.										

MANIPAL UNIVERSITY

Deemed- to -be -University under Section 3 of the UGC Act, 1956

DEPARTMENT OF SCIENCES, MSc (P/C/M/G)
IV SEMESTER END SEMESTER EXAMINATIONS, APRIL 2018

SUBJECT: THERMODYNAMICS AND STATISTICAL PHYSICS (PHY- 702)
(REVISED CREDIT SYSTEM)

Time: 3 Hours | Date: 17-04-2018 | MAX. MARKS: 50

Note: (i) ANSWER ANY FIVE FULL QUESTIONS. (B) EACH QUESTION CARRIES 10 MARKS.
(ii) ANY MISSING DATA MAY SUITABLY BE ASSUMED

1A. Explain Nernst's heat theorem and its consequences. [6]

1B. Obtain the TdS equations. [4]

2A. Calculate the volume element in the phase space for a harmonic oscillator, and obtain an expression for the number of quantum states in a volume element of the phase space. [5]

2B. State and prove Liouville's theorem. [5]

3A. Derive the statistical interpretation of entropy with reference to micro-canonical ensemble. [5]

3B. Obtain the most probable distribution of energy in a canonical ensemble. [5]

4A. A diatomic gas is in thermal equilibrium at temperature 500 K. Its rotational constant is B = 200/m. Compute the rotational populations (in terms of ground state population) in the rotational states: J = 0, 10, 20. The rotational energy is $E = J(J+1)\, h\, c\, B$. Boltzmann constant = 1.38×10^{-23} J/K, Speed of light in vacuum = 3.00×10^{8} m/s, Planck's constant = 6.63×10^{-34} J.s. [5]

4B. Derive the expression for grand canonical partition function and hence grand canonical distribution. [5]

5A. Deduce Stefan's law from Planck's law of radiation. [3]

5B. Discuss the Pauli's theory of paramagnetism of an ideal Fermi-gas and derive an expression for the magnetic susceptibility. [7]

6A. Obtain the relation between the fractional fluctuation in energy of a canonical system and the number of particles in the system. **[5]**

6B. Setup the diffusion equation and solve it. Show that $\langle r^2(t) \rangle = 6\,D\,t$. **[5]**

Useful formulae:

Stirling formula: $n! \cong (2\pi n)^{1/2} n^n e^{-n}$

$$\ell n(1+x) = x - \frac{x^2}{2} + \frac{x^3}{3} - \cdots \quad , \quad |x| < 1$$

$$e^x = \sum_{o}^{\infty} \frac{x^n}{n!}$$

$$\int_o^\infty x^r e^{-nx}\, dx = \frac{r!}{n^{r+1}}$$

$$\int_o^\infty x^4 \exp\,(-ax^2)\, dx = \frac{3}{8a^2}\sqrt{\frac{\pi}{a}}$$

$$\int_o^\infty x^2 \exp\,(-ax^2)\, dx = \frac{1}{4a}\sqrt{\frac{\pi}{a}}$$

$$\int_o^\infty \frac{x^{n+1}}{e^x - 1}\, dx = \Gamma(n)\,\zeta(n)$$

$\Gamma(n+1) = n!$ if n is an integer

$\Gamma(n+1) = n(n-1)\cdots\frac{3}{2}\cdot\frac{1}{2}\cdot\sqrt{\pi}$ if n is half integral

$$\zeta(4) = \frac{\pi^4}{90}$$

$$\zeta\left(\frac{5}{2}\right) = 1.341$$

$$\zeta\left(\frac{3}{2}\right) = 2.612$$
