Ref. No. EX/ET/Ph/T/1B/115/2019 (Old)

B. E. ELECTRONICS AND TELE-COMMUNICATION ENGIMEERING EXAMINATION 2019 (Old)

(1^{st} year, 1^{st} Semester)

PHYSICS IB

Time : Three hours Full Marks: 100

Answer any five

GROUP A

1. (a) What do you mean by microstates and macrostate of a system. Give one example in each case. Discuss the concept of ensemble in statistical mechanics. What is the difference between canonical and microcanonical ensemble 6 + 3 + 2

   (b) Discuss the concept of phase space. What do you mean by equation of state of the system. Derive the general expression for an equation of state of a canonical ensemple. 3 + 2 + 4

2. (a) explain various type of thermodynamic equilibrium when two systems are interacting each other. 5

   (b) Calculate the probability P_r that the canonical system is in the energy state E_r and hence define the partition function. 5

   (c) Use general expression of entropy to derive the expression for entropy of a canonical ensemble. 5

   (d) Calculate the partition function of a one dimensional simple harmonic oscillator 5

3. (a) Explain the term postulate of equal apriori probability. 3

   (b) Calculate the canonical partition function of an ideal classical gas 5

   (c) calculate the equation of state, entropy of an ideal gas from the partition function. 6

   (d) What is Gibb's paradox? How was the paradox resolved? 6

4. (a) What is a reversible engine? Find an expression for the efficiency of Carnot's engine.

   (b) What is the maximum work a Carnot engine can perform per kilo calorie of heat which absorbs heat at 247°C and exhaust heat at 117°C?

   (c) Compute the entropy change of a system consisting of 1.00 kg of ice at 0°C which melts to water reversibly at the same temperature. Latent heat of melting 79.6 cal/gm. 10+5+5

5. (a) Distinguish among reversible, irreversible and cyclic process.

(b) State and explain the First law of thermodynamics

(c) Show that for isothermal process, work done depends upon path.

(d) Show that $C_p - C_v = R$. 5+5+5+5

6. (a) Convert a rectangle in P-V diagram to T-S diagram 3

(b) If a real gas undergoes an adiabatic change, prove that

$$(P + \frac{a}{V^2})(V - b)^{\frac{R+C_v}{C_v}} = constant \quad (1)$$

Where symbols have their usual meaning. 7

(c) Derive four Maxwells thermodynamic relations. 10

7. (a) Show that the Gravitational field is conservative. 5

(b) Prove that the torque about the origin of a coordinate system is equal to the time rate of change of angular momentum. 3

(c) A particle of mass 2 moves in a force field depending on time t given by $\vec{F} = 24t^2\hat{i} + (36t - 16)\hat{j} - 12t\hat{k}$ Assuming that at $t = 0$ the particle is located at $r_0 = 3\hat{i}\hat{j} + 4\hat{k}$ and has velocity $v_0 = 6\hat{i} + 15\hat{j} - 8\hat{k}$, find
(i) the velocity
(ii) the position at any time t
(iii) the torque about the origin at any time t
(iv) the angular momentum about the origin at any time t

8. (a) A force $\vec{F}$ acting on a particle in the XY plane is given by $\vec{F} = (x^2+y^2)\hat{i}+cxy\hat{j}$, where c is a constant. For what value of c, the force $\vec{F}$ is conservative. find the work done by the force in moving a particle along the path from (0,0) to (0,2) and then from (0,2) to (3,2). 3 + 4

(b) Define unit vectors in cylindrical coordinate system. Express the vector $\vec{A} = 2z\hat{i} - 3x\hat{j} + y\hat{k}$ in cylindrical coordinates (ρ, ϕ, z) and identify A_ρ, A_ϕ and A_z. 3 + 5

(c) A point moving in a plane has co-ordinates x = 3, y =4 and has components of speed $\dot{x} = 5$ cm/s , $\dot{y} = 8$ cm/s at some instant of time. Find the components of speed in polar coordinate systems, r, θ along the directions $\hat{r}$ and $\hat{\theta}$ 5