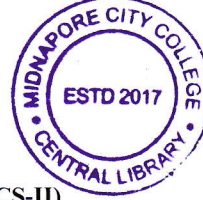


**PG (CBCS)**  
**M.Sc. Semester- IV Examination, 2023**  
**PHYSICS**  
**PAPER: PHS 401**  
**(PARTICLE PHYSICS & STATISTICAL MECHANICS-II)**



Full Marks: 40

Time: 2 Hours

**Write the answer for each unit in separate sheet**

The figures in the right-hand margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

**PHS 401.1**

**PARTICLE PHYSICS**

**F.M. - 20**

**GROUP-A**

1. Answer any **TWO** of the following questions: 2×2=4
- If  $pp \rightarrow d\pi^+$  and  $pn \rightarrow d\pi^0$  where d is deuteron. Prove that  $\sigma_{pp} : \sigma_{pn} = 2:1$ .
  - What is the difference between a pseudoscalar meson and a vector meson?
  - In SU (3), the generators are  $\lambda_a$  and  $\lambda_b$ , then  $[\lambda_a, \lambda_b] = \dots\dots\dots$ .
  - Calculate the mass of baryon ( $uuu$ ).

**GROUP-B**

2. Answer any **TWO** of the following questions: 4×2=8
- Why para-positronium decay into two photons and ortho-positronium decay into three photons?
  - Calculate the branching ratio for the decay of the resonance  $\Delta^+(1232)$  which has two decay modes.  

$$\Delta^+ \rightarrow p\pi^0$$

$$\rightarrow n\pi^+$$
  - What is  $\tau - \theta$  puzzle? How it is resolved?
  - What is G-Parity? Find an expression of it.

**GROUP-C**

3. Answer any **ONE** of the following questions: 8×1=8
- $\pi^+ + p \rightarrow \Sigma^+ + K^+ \dots\dots(a)$ ;  $\pi^- + p \rightarrow \Sigma^- + K^+ \dots\dots(b)$ ;  $\pi^- + p \rightarrow \Sigma^0 + K^0 \dots\dots(c)$ ; If iso-spin amplitude  $a_{1/2} \ll a_{3/2}$  and these reactions occur at same energy. Show that  $\sigma_a : \sigma_b : \sigma_c = 9:1:2$ .
  - Construct the famous Gell-Mann matrices and identify the iso-spin states of each particle in the meson octet.

(1)

(P.T.O)

**PHS 401.2**  
**STATISTICAL MECHANICS-II**  
**F.M. - 20**

**GROUP-A**

1. Answer any **TWO** of the following questions: 2×2=4
- Determine the Bose temperature of bosons each of mass  $6.65 \times 10^{-27}$  kg and spin zero, their concentration being  $10^{26} \text{ m}^{-3}$ .
  - Using  $\ln G_Z = -\sum \ln(1 - \eta e^{-\beta E_i})$ . Show that the number of particles in the ground state,  $N_0 = \frac{\eta}{1-\eta}$ , where  $\eta$  is the fugacity.
  - Draw the temperature variation of chemical potential for FD and BE ideal gas.
  - Prove that total number of photons in a cavity  $\sim T^3$ .

**GROUP-B**

2. Answer any **TWO** of the following questions: 4×2=8
- Show that the Helmholtz free energy of a system of fermions is given by  $F = \frac{3}{5} N \varepsilon_F^{(0)} \left[ 1 - \frac{5\pi^2}{12} \left( \frac{kT}{\varepsilon_F^{(0)}} \right)^2 + \dots \right]$ .
  - Find the expression of Null pressure of Fermi-gas in 2D.
  - How many photons are there in 1c.c. of radiation at  $10^4 \text{K}$ . Also find their average energy.
  - Prove that in 3D solid of N Harmonic oscillator,  $E_0 = \frac{9}{8} N k_B T_D$  where  $T_D$  is the Debye Temperature.

**GROUP-C**

3. Answer any **ONE** of the following questions: 8×1=8
- Find an expression of photoelectric current density if  $h\nu \ll \phi$ , where  $\phi$  is the work function of metal.
  - (i) In a lattice of (N+1) sites has  $S_i = \pm 1$  at each site,  $\hat{H} = -h \sum_{i=0}^N S_i - J \sum_{i=1}^N S_i S_0$ . When  $h=0$ , prove that  $\langle S_i S_j \rangle = \langle S_0 S_i \rangle \langle S_0 S_j \rangle$ . (ii) If  $\varepsilon(l, p_z) = \left( l + \frac{1}{2} \right) \hbar \omega_c + \frac{p_z^2}{2m}$ , find degeneracy of each Landau level.

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