#### PG CBCS

# M.Sc. Semester-IV Examination, 2022 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

#### Marks: 20

# **GROUP-A**

#### 1. Answer any two questions:

 $2\times2=4$ 

- a) In Natural unit, Show that 1 Sec =  $1.5 \times 1024 \text{ GeV}^{-1}$
- b) Show that time reversal operator is anti linear.
- c) Which interactions are responsible for the below process?

(i) 
$$\pi^- + p \rightarrow \kappa^0 + \Sigma^0$$

(ii) 
$$e^+ + e^- \rightarrow \mu^+ + \mu^-$$

d) What is the difference between a pseudoscalar meson and a vector meson?



# **GROUP-B**

# 2. Answer any two questions:

 $2 \times 4 = 8$ 

- a) Consider the decay of  $\kappa^0$  meson of momentum  $p_0$  into and of momentum  $\pi^+$  and  $\pi^+$  in the opposite direction such that  $p_+ = 2p_-$ . Find  $p_0$ . ( $m_{\kappa^0} = 498 \text{ MeV/C}^2$ ,  $m_{\pi^\pm} = 140 \text{ MeV/C}^2$ )
- b) State and prove CPT theorem.
- c) In SU(3) multiplets, prove that  $3\otimes 3=6\oplus \bar{3}$ . How many symmetric and antisymmetric states are there?
- d) State that  $\pi^- + d \rightarrow n + n + \pi^0$  cannot occur for pions at rest.

#### **GROUP-C**

# 3. Answer any one questions:

1×8=8

- a) Construct the famous Gell-Mann Matrices and identify the iso-spin states of each particle in
- b) What is  $\tau$   $\Theta$  puzzle? How it is resolved? Show that  $e^+e^- \to 2\gamma$  is forbidden.

(Turn Over)

#### PHS 401.2 Statistical Mechanics-II

#### Marks: 20

# **GROUP-A**

# 1. Answer any two questions:

 $2 \times 2 = 4$ 

a) Plot the temperature dependence of fugacity for BE and FD statistics.

b) If 
$$E = \frac{3}{2}Nk_BT\frac{B_{5/2}(\alpha)}{B_{3/2}(\alpha)}$$
 where  $\alpha = -\mu\beta$ , show that  $C_V \propto T^{3/2}$  in case of BE condensation at

T<T<sub>c.</sub>c) Using InG<sub>z</sub> =  $-\sum \ln \left(1 - \eta e^{-\beta E_t}\right)$  Show that the number of particles in the ground state,

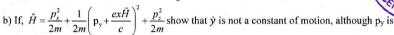
 $N_0 = \frac{\eta}{1 - \eta}$  Where  $\eta$  is the fugacity.

d) Consider 4 spin half particle system. How many microstates are possible for total magnetic moment zero?

# GROUP-B

#### 2. Answer any two questions:

a) For BE condensation, prove that  $F = -\frac{2}{3}$  E. at T<Tc



constant.  $\hat{H}$  = magnetic field along z-direction.

- c) Find an expression of Fermi energy for 2D metallic system.
- d) Prove that free energy of photon gas is  $F = -\frac{a}{3}VT^4$ , where 'a' is a constant.

#### **GROUP-C**

# 3. Answer any one questions:

1×8=8

- a) In Ising model prove that long range order parameter  $L(T) = \tanh \mu_0 \beta \left( H + \frac{\gamma J_e L}{\mu_0} \right)$ , where  $\gamma = n.n$  and other symbols has their usual meaning.
- b) Prove that average occupation number  $\langle N \rangle = \frac{zV}{\lambda^3} \frac{x}{\sinh(x)}$ , in Case of Landau

diamagnetism. Where 
$$x = \frac{\beta \hbar e H}{2mc}$$
,  $\lambda = \frac{h}{\sqrt{2\pi m k_B T}}$  and  $z = e^{\mu\beta}$ .

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