Sem-5 Honours Examination, 2020

Internal Examination

Sub – PHSA Paper - CC-11

FM – 20 Time - 30 mins

Answer any ten questions. Each question carries 2 marks.

1. State the cause of discrepancy between classical and quantum probability that occurs at the ground state of a quantum harmonic oscillator.

2. If the total energy of a quantum system is less than the potential energy of the system, the corresponding wave function can not be normalized - explain.

3. Explain the appearance of even and odd states in succession in case of a quantum harmonic oscillator.

4. Consider a potential of the form

$$V(x)=\frac{1}{2}m\omega^2x^2 \text{ for } x<0$$
$$V(x)=\infty \text{ for } x\geqslant 0$$

What should be the eigenstates and corresponding energy eigen values for the oscillator.

5. How is free particle wave function normalized ?

6. What are spherical harmonics ?

7. Eigenvalues of the angular momentum operator J^2 are $j(j+1)\hbar$. Write down the vector space corresponding to $j=2$, on which J^2 acts.

8. Briefly discuss how Stern-Gerlach experiment indicated the existence of a new variable.

9. How is it possible to express an arbitrary spinor in terms of the eigenstates of S_z ?

10. How is it possible to express spin precession through expectation values of the spin operators ?

11. Write down the spin orbit coupling correction term and the Darwin term for explanation of the fine structure of H-atom.

12. What is the basic difference between the Zeeman effect and Paschen back effect ?

13. What is the value of the first order Stark effect for the ground state of H-atom ? What is linear Stark effect ? What is quadratic Stark effect?

14. Write down the Zeeman correction energy in first order perturbation, clearly explaining Lande 'g' factor.

15. Suppose we have two non interacting particles, both of mass m, in the infinite square well. The one particle states are

$$\psi_n(x) = \sqrt{\frac{2}{a}} \sin\frac{n\pi x}{a}\ ,\ E_n = n^2 k \quad where\ \ k = \frac{\pi^2 \hbar^2}{2ma^2}$$

(a) If the two particles are identical bosons, write down ground state , first excited state wave functions . 1

(b) If the two particles are identical fermions, what are the ground state and first excited state wave functions. How can you conclude about the Pauli's principle in this case? 1

INTERNAL EXAMINATION
SEMESTER-V
CC12
FULL MARKS 20

2×10

ANSWER ANY **TEN (10)** QUESTIONS

1. Define Polarizability.
2. What are the four processes of Polarization?
3. What are normal and Anamolus Dispersion?
4. What are ferromagnetic domains?
5. What is Hysteresis?
6. What are Miller Indices?
7. What is Brillouin Zone?
8. What is the significance of Reciprocal Lattice?
9. What are phonons. Discuss its properties?
10. What are the essential differences between Debye and Einstein Theory of specific heat?
11. State Bloch's theorem in periodic crystal.
12. Define hall coefficient. Write the expression of hall co-efficient for p-type semiconductor.
13. What is the difference between good conductor and superconductor?
14. What is the difference between Type I and Type II superconductors?
15. Write down the first London equation explaining each term.

Sem-5 Honours Examination, 2020

Internal Examination

Sub – PHSA

Paper - DSE-A1(Advanced Mathematical Methods)

FM - 20 Time - 30 mins

Answer any ten questions. Each question carries 2 marks.

1. Show that a binary operation on a set cannot have more than one identity element.

2. Let $A = \{1, 2, 3\}$ and $B = \{4, 5, 6\}$ be two sets. Which one of the followings is a relation from A to B? (i) $R_1 = \{(1,4), (5,1), (1, 6)\}$ and $R_2 = \{(1,5), (2,6)\}$.

3. Let Z is the set of all integers and there is an operation defined as $a \circ b = a - b$ for every $a, b \in Z$. Does Z form a group under this operation?

4. Show that $u = (a, b)$ and $v = (c, d)$ in R^2 are linearly dependent if and only if $ad - bc = 0$.

5. Consider $u = (1 + i, 3, 4 - i)$ and $v = (3 - 4i, 1 + i, 2i)$ in C^3. Find $\langle v, u \rangle$.

6. Show that the gradient of a scalar field is a covariant tensor of rank one.

7. Write down the transformation rule of a mixed tensor of contravariant rank one and covariant rank two.

8. In cartesian coordinate system, the contravariant and the covariant parts of a tensor are same – why ?

9. Write down the transformation rules of the inner product and the outer product of two tensors.

10. Write down the condition under which two tensors A and B are conjugate.

11. State Lagrange's theorem in group theory.

12. What are cosets ?

13. What are permutation groups of an equilateral triangle ?

14. Define kernel of homomorphism and give an example.

15. Suppose H be a subgroup of G and X be an element of G but not an element of H. Show that $X H_i$ does not belong to H, H_i being an element of H.

Sem-5 Honours Examination, 2020

Internal Examination

Sub – PHSA

Paper - DSE-A1(Laser and Fibre Optics)

FM – 20 Time : 30 mins

Answer any ten questions. Each question carries 2 marks.

1. What is stimulated light amplification ?
2. What is meant by population inversion ?
3. How is coherence defined in quantum theory ?
4. Explain spontaneous emission and stimulated emission.
5. Explain the basic principle of production of LASER.
6. What is an optical resonator ?
7. What is the stability condition of an optical resonator ? What should be the fate of the beam if it does not satisfy the stability condition ?
8. How is Q-switching achieved in an optical resonator ?
9. Explain how can a LASER be made to produce pulses of extremely short duration.
10. What is the basic principle of LASER cooling ?
11. What is second harmonic generation ?
12. Write down susceptibility tensor.
13. What is meant by numerical aperture of an optical fiber ?
14. Explain the functioning of holographic technique.
15. Define nonlinear optical susceptibility.

SEM 5 DSE B1 (NUCLEAR PHYSICS) INTERNAL

Answer ***any ten*** questions

F.M:10x2=20

1. What is Cerenkov radiation?

2. Define photoelectric effect.

3. What is pair production?

4. What happens in Compton scattering?

5. What is photomultiplier tube?

6. Show that an electron confined in a box of nuclear dimension must have an energy more than 20 MeV

7. What do you mean by thermal neutrons? Indicate their key role in nuclear reaction.

8. What is Q – value of the nuclear reaction?

9. What is nuclear 'magic numbers'?

10.What is stripping reaction?

11. Name the mediators of weak force.

12. What is the role of resonance in the operation of cyclotron

13. Show that the kinetic energy of the charged particle in the cyclotron is proportional to the square of the orbit radius.

14. What are strange particles? Why they are called "Strange"?

15.What are "gluons"?

Sem-5 Honours Examination, 2020
Internal Examination

Sub – PHSA Paper : DSE-B1(Astrophysics)

FM – 20 Time - 30 mins.

Answer any ten questions. Each question carries 2 marks.

1. What is the importance of Chandrasekhar limit on the mass of stars?
2. If in the spectrum of the supernova Balmer lines of hydrogen are absent. What is the type of the Supernova?
3. What is the position of our solar system on the Milky way Galaxy?
4. Describe Hubble's tuning fork diagram for the classification of the Galaxies?
5. State the importance of Radio telescope over optical telescope.
6. What is binary system of stars? Give one example.
7. What is Cosmic Microwave Background?
8. State and explain Hubble's law.
9. What is Olber's paradox?
10. Write Friedmann equation and explain the symbols.
11. What is Helium ignition of stars?
12. What do you mean by Pulsers?
13. What is the use of Hertzsprung-Russell diagram?
14. Assuming the distance to the Coma Cluster of galaxies to be 100 Mpc and that it moves with a constant velocity, calculate the distance it will move through in one billion years. Assume $H = 75\, km\, s^{-1} Mpc^{-1}$
15. What are white dwarfs ?