

# **M.Sc Question Bank**

## **Semester-II**

### **Paper-Atomic and Molecular Physics**

1. What is Chirp cooling?
2. Discuss the process of slowing an atomic beam?
3. What do you mean by ortho and para Helium?
4. Why intensity of Antistoke's line is less than Stoke line?
5. Compare Infra-red Spectra and Raman Spectra.?
6. (a)Discuss the Optical Molasses technique and deduce an expression for damping coefficient.  
  
(b)Describe the Sisyphus cooling and explain the cooling of the atom through absorption and Spontaneous emission process at the top of hill and at the bottom of valley.
7. (a)Explain how the Variational method is used to calculate ground state energy of a hydrogen molecule.  
  
(b)Discuss how Pauli's exclusion principle is connected with the symmetry of the wave function.
8. Discuss types of molecular spectra. Explain the molecule as a rigid rotator.

# Paper-Classical Electrodynamics II

1. Explain the properties of electromagnetic waves.
2. Write the difference between group velocity and phase velocity.
3. Write the MHD equations for plasma.
4. Write a short note on oscillations in plasma and explain plasma frequency.
5. Define incoherent and coherent scattering.
6. Explain Thomson scattering.
7. Explain the radiation reaction force from conservation of energy.
8. What is the line breadth of an oscillator?
9. Explain the behavior of EM waves in conducting media.
10. Explain the behavior of EM waves in dielectric.
11. Derive and explain the self-confinement of plasma
12. Write down the wave equations and solutions of Alfvén waves in detail.
13. Find the power radiated by accelerating charged particles in the non-relativistic motion and describe its angular distribution.
14. Write down the Lienard Wiechert potential produced by a moving point charge. Obtain the corresponding electric and magnetic field and identify their respective induction and radiation parts. Show that there is no radiation of charge if its acceleration is zero.
15. Discuss the Abraham Lorentz model and what are the difficulties with the model?
16. Write down the integro-differential equation of motion including radiation damping.
17. Explain the terms:
  - Plasma

- Domains of Magneto hydrodynamics.
- Sausage and Neck Instability
- Debye screening distance

18. Derive instabilities in a pinched plasma column.

19. (a) Derive the Magneto hydrodynamic equation.

20. Explain the electromagnetic and mechanical behavior of fluid.

# Paper-Mathematical Methods in Physics

1. Prove that fundamental tensor (matrix tensor)  $g_{pq}$  is covariant tensor of rank two and is symmetric also.
2. Explain relative tensor and pseudo tensor.
3. Define generators of a finite group.
4. What is subgroup? Also define normal subgroup.
5. What do you mean by momentum representation? Write down the three properties of momentum wave function.
6. Write down any two properties of Laplace transformation.
7. Find out the Laplace transformation of
  - (a)  $t \sin t$
  - (b)  $\cos^2 2t$
8. Express Maxwell's equations for the electromagnetic field in covariant tensor form.
9. What are the Christoffel symbols? Define the type and properties of Christoffel symbols.  
Calculate the Christoffel symbols corresponding to the matrix:  $ds = (dx^0)^2 + (x^0)^2 \cdot (dx^2)^2 + (x^0)^2 \cdot (\sin x)^2 \cdot (dx^3)^2$   
Where  $g_{11} = 1$ ,  $g_{22} = (x^0)^2$ ,  $g_{33} = (x^0)^2 \cdot (\sin x)^2$ ,  $g_{ij} = 0$  for  $i \neq j$
1. Define isomorphism and homomorphism. Discuss representation theorem of finite groups.
2. Define invariant subspace and reducibility of a representation.
3. State and prove the convolution theorem of inverse Laplace transformation.
4. Solve  $t^2 \cdot \cos t$  using convolution theorem.

5. State and prove initial and final value theorem.
6. Solve  $2y'' + 5y' + 2y = 2e^{-2b}$  where  $y(0) = 1$ ,  $y'(0) = 1$
7. Define and evaluate the momentum representation of diffraction by a single slit.
8. State and prove the convolution theorem of Fourier transformation and prove that  $F\{f(x) \times g(x)\} = F\{f(x)\} \cdot F\{g(x)\}$
9. Show that the Fourier transformation of  $n^{\text{th}}$  derivative is  $g_n(\omega) = (-i\omega)^n g(\omega)$ .

The condition  $g(x) \rightarrow 0$  for  $x \rightarrow \infty$  may be relaxed slightly. Find the last restrictive condition for the Fourier transform of second derivative  $g_2(\omega)$  to hold.

# Paper-Numerical Analysis

1. Explain with example Absolute and Relative error.
2. Write a short note on Singular Integral.
3. Solve by Gauss Quadrature

$$\int_0^1 x dx$$

4. Find sum of numbers 105.5, 27.25, 6.56, .1568, .000256, 208.6 .0235, .538, .0571 where each number is correct to the digits given. Estimate absolute error.
5. Derive Simpson's  $\frac{1}{3}$ <sup>rd</sup> rule using method of undetermined coefficients.
6. (a) Find eigen value and eigen vector for matrix

$$\begin{pmatrix} 1 & 3 & -1 & 3 & 2 & 4 & -1 & 4 & 10 \end{pmatrix}$$

- (b) Using Hermite interpolation formulae estimate value of  $\ln 3.2$  from table:-

x	$y = \log_e x$	$y = 1/x$
3.0	1.09861	.3333
3.5	1.25276	.2857
4.0	1.38629	.25000

- (c) From given table evaluate x for which  $\sinh x = 5$

x	$\sinh x$
2.2	4.457
2.4	5.466
2.6	6.695
2.8	8.198
3.0	10.018

- (d) Given the set of points (1-8), (2-1), (3-18) satisfying  $y=f(x)$ . Find linear splines satisfying the given data. Determine the approx. value of  $y(2.5)$  &  $y^{-1}(2.0)$

7. (a) Solve  $x^2 - y^2 = 4$ ,  $x^2 + y^2 = 16$  by Newton Raphson method

(b) Find a real root of

$$x = 2x^2 + 8$$

$$y = 3xy^2 + 7$$

(c) Evaluate

$$\int_0^1 \int_0^1 e^{x+y} dx dy$$

Using trapezoidal with  $h=k=0.5$

(d) Evaluate  $\int_2^4 \int_0^4 (x^2 - xy + y^2) dx dy$  by Simpson's  $1/3^{\text{rd}}$  rule

# **Paper- Condensed Matter Physics-I**

1. Explain Gibbs phase rule? Find out degree of freedom for one component system ( $H_2O$ ).
2. Write any four properties according to Hume Rothery Rule for the formation of substitutional Solid Solution.
3. Define characteristics of X-rays and give decay scheme of  $Na^{22}$ .
4. Define critical temperature & critical magnetic field in superconductors.
5. What is Meissner effect?
6. Explain two component (Binary) system and their type with example.
7. Explain XPS technique in detail to characterize sample.
8. Explain XAS technique. Define XANES, XAFS and pre edge absorption.



# **Paper- Nanotechnology-I**

1. Define Nanotechnology.
2. Write different modes of classification of nanomaterials.
3. List out the applications of nanotechnology.
4. Write the properties of crystalline solid.
5. Explain Drude Model.
6. Explain in detail electrical, magnetic, optical, thermal and mechanical properties of nanostructured materials.
7. Discuss top down and bottom up approaches for the synthesis of nanomaterials & write advantages & disadvantages of the approaches.
8. (a) Discuss free electron model theory and energy bands.  
(b) Discuss Hall Effect in detail.