

Syllabus

Interview Support Program for Graduate Students

A. Mathematical Physics (Reference: Mathematical Methods for Physics by Arfken, Erwin Kreyszig)

1. Curve Tracing of important functions: Exponential curve, Hyperbolic curve, Modulus, gaussian, etc. understanding the nature of the curve using maxima minima and functional values.

Practice following curve tracing:

(a) Algebraic

$$f(r) = \frac{a}{r^2} - \frac{b}{r} \text{ for } r > 0, f(x) = ax^2 + \frac{b}{x^2}, a, b > 0, f(x) = \frac{x^2}{2} - \frac{x^3}{3}, f(x) = \frac{x^2}{2} - \frac{x^4}{4}$$

$\log(x), x \log(x)$

(b) Trigonometric $\sin x, \cos x, \tan x, x \sin x, x \cos x, \frac{\sin x}{x}, \frac{\cos x}{x}$.

(c) Exponential and Modulus curve $\frac{e^x}{x}, |x|, e^{|x|}, e^{-|x|}, |\sin x|, |\cos x|$.

(d) Hyperbolic curve $\sinh x, \cosh x, \tanh x, \sec hx$.

Suggested Tools for curve tracing: www.wolframalpha.com, www.desmos.com, www.geogebra.org

2. Fundamentals of Fourier Transformation, Laplace transform.
3. Matrices: Property of Hermitian and Unitary matrix, Pauli spin matrices.

Practice eigen values and eigen vectors of matrices $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}$

$$\begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}, \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix}, \begin{bmatrix} 0 & 0 & 1 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{bmatrix}$$

Function of matrices

4. Differential Equation: solution of particle in gravitational field, Particle under damping harmonic oscillator, charge particle under EM field, Damped and Forced Oscillator, LCR circuit

B. Classical Mechanics (Reference: Goldstein and Klepner)

1. Motion of simple Pendulum, moving pendulum, rotating pendulum double pendulum and Concept of Small Oscillation, Damped oscillation.
2. Central force problem, Two Body Problems, Sun Earth System Kepler's three laws.

C. Quantum Mechanics (Reference: Arthur Beiser, Introduction of Quantum Mechanics by D. J. Griffith)

1. Notes by Pravegaa.
2. Particle properties of light, Wave Properties of particles, Atomic structure.
Results and setup of different experiments.
 - (a) Photo electric effect.
 - (b) Compton effect.
 - (c) Davisson Germer effect.
 - (d) Stern-Gerlach experiment.
3. Schrödinger's Theory of Quantum Mechanics, solution of time-Independent Schrödinger Equation.
Complete analysis of solution of Schrodinger wave equation
 - (a) Particle in a box.
 - (b) Harmonic Oscillator.
 - (c) Dirac Delta Potential.
 - (d) Hydrogen atom.

D. Statistical Mechanics and thermodynamics (Reference: R.K. Pathria)

1. Laws of thermodynamic property, Maxwell relations and thermodynamical potential.
2. Identical particles.
 - (a) Maxwell Boltzmann distribution.
 - (b) Fermi Dirac distribution.
 - (c) Bose Einstein distribution.
3. Ensemble Theory: Microcanonical, Canonical Ensemble and Grand Canonical.
Complete analysis of thermodynamic physical quantity at equilibrium temperature.
 - (a) Free particle.

E. Optics and Waves (Reference: Ajoy Ghatak)

1. Ray optics - Fermat's principle, Snell's law, Total internal reflection, Properties of dispersion.
2. Interference: Young's double slits, Newton's Ring and Michelson Morle Experiment
3. Diffraction: Single slit, Double slit
4. Polarization: Malus law, Brewster Angle

F. Electromagnetic Theory Electrodynamics (Reference: David J. Griffiths)

1. Maxwell's Equations (differential and Integral form)
 - (a) General Maxwell's Equations
 - (b) Inside Matter
 - (c) Applications of Gauss law.
 - (d) Boundary Conditions
2. Propagation of Electromagnetic Waves in
 - (a) In free space
 - (b) Inside Dielectrics
 - (c) Inside conductors
3. Reflection and Refraction at Interface
 - (a) Brewster Angle
 - (b) Critical Angle
 - (c) Total Internal Reflection
4. Potential Formulation for time varying fields.
5. Concept of Vector potential and scalar potential.
6. Applications of Ampere circuital law.

G. Solid State and electronics Physics (References: C. Kittel and M.A. Wahab)

1. Fundamental of space Lattice, Symmetry Operation (Translational, Reflection & Inversion Symmetry Operator), Concept of Lattice in 2D and 3D.
2. Miller Indices, Planar Spacing, Packing Fraction, Diamond Cubic Structure, HCP Structure, $NaCl$, ZnS and $CsCl$ Structure.
3. Reciprocal Lattice and X -ray Diffraction of Crystal (Structure Factor Calculation of SC, BCC, FCC, Hexagonal) and Braggs Law.
4. Heat capacity of solid.
5. Semiconductor Physics.
6. Diode Application.
7. Basic Transistor.
8. Op-Amp.

H. Nuclear Physics

1. Basic properties nucleus.
2. Binding energy Curve (Detail).