DEPARTMENT OF PHYSICS

M.Phil. Restructured syllabus

(Effective from 2003-2018)

Semester	Nature	Code	Course Title	Credits
I	MC	PH1117	Quantum Field Theory And Condensed Matter Physics	6
	MC	PH1118	Techniques & Tools for Physicists	6
	ES	PH1157	Advances In Material Sciences	6
II	MC	PH1217	Dissertation & Viva Voce	18
Total Credits				36

PH-1117: Quantum Field Theory And

Condensed Matter Physics

Paper – 1

Semester: I Credits: 6

Course: Major Core (MC) Hours/Week: 6

Unit 1: Dirac Equation And Spin Of The Electron: Plane Wave Solutions and Negative Energy States; Covariant Form Of Dirac Equation-Invariance of Dirac Equation Under Lorentz Transformation-Form Of 'S' For Proper Lorentz Transformation-Charge Conjugation Zero Mass Dirac Equation

Theory Of Fields: Euler Lagrange's Equations of Motion-Canonical Coordinates for the Fields-Real Scalar Field Complex Scalar Field Schrodinger Field –Dirac Field –Maxwell Field –Proca's Field

Unit 2: Quantization Real Scalar Field –Classical Radiation Field- Creation Annihilation And Number Operators –Quantized Radiation Field – Emission And Absorption Of Photons By Atoms –Dipole Approximation –Rayleigh Scattering .Thomson Scattering And Raman Effect

Unit 3: Single Particle Approximation: The Hartree And Hartree –Fock Approximation-Hartree-Fock Theory Of Free Electrons –Density Functional Theory

Electron as Quasi Particles: Quasi Particle And Collective Excitation-Thomson Fermi Screening

Electrons In Periodic Potential :Bloch States-K-Space Brillouin Zone Dynamic And Crystal Electrons-Crystal Symmetries Beyond Periodicity –Symmetries Of The Band Structure-Symmetries Of 3d Crystals

Unit 4: Band Structure Of Crystals: The Tight Binding Approximation –Pseudo Potential Method. Band Structure Of Semi Metal –Graphite-(2dsolid) B.S Of Semi-Conductors And Insulators. (3d Covalent Solids) B.S Of Metallic Solids.

Application Band Theory: Density Of States-Tunneling Of Metal –Semiconductor Contact-Optical Excitation –Conductivity And Dielectric Function. Exitons: Energetics And Dynamics: Total Energy –Force And Dynamics

Unit 5: Magnetic Behavior Of Solids: Classification Of Magnetic Materials-Atomic Theory Of Magnetism-Langevin's Classical Theory –Domain Theory-Heisenberg Spin Model –Spin Waves In The Heisenberg Ferromagnetic Model- Heisenberg Anti Ferromagnetic Spin Model –Classical And Quantum Hall Effect

Books for Study:

1. Advanced Quantum Theory And Fields-S L Gupta And I.D Gupta ,S Chand &Co.,2004
2. Advanced Quantum Mechanics- J.J Sakurai ,Pearson Education (Singapore) Pvt. Ltd.,2004
3. Atomic And Electronic Structure Of Solids –Efthmios Kaxiras Cambridge University.,2003
4. Solid State Physics , Structure And Properties Of Material-M.M Wahab, Narosa Publishing House Pvt Ltd., Second Edition 2005

Books for References:

1. Solid State Physics-Aschcroff And Mermin, Harcourt College Publisher.,2001
2. Solid State Physics-S Rogaisk And B Palmer Gerdon And Breach Science Pubisher., 2001
3. Solid State Physics-Ajay Kumar, Saxema, Macmillan Publisher.,2006
4. Relativistic Quantum Mechanics-Bjorken And Drell., 2005

PH-1118: Techniques & Tools for Physicists

Paper – II

Part–I: Techniques

Semester: I Credits: 6

Course: Major Core (Mc) Hours/Week: 6

1) Mathematical Techniques:

a) **Tensor Analysis:** Physical Law-Spaces Of N Dimensions-Coordinate Transformations The Summation Conventions-Contra Variant, Covariant And Mixed Tensors-The Kronecker Delta-Tensors Of Rank Greater Than Two-Scalars Of Invariants-Tensor Field-Symmetric And Skew-Symmetric Tensors-Fundamental Operations With Tensor.

b) **Finite Fourier Transform:** The Finite Fourier Sine And Cosine Transforms-Fourier Integral Theorem- Parseval's Identity-Problems Related To Fourier Integral.

2) Statistical Techniques:

Elementary Ideas Of Probability Distribution-Random Variables-Expected Value And Variance-Estimation Of Parameters-Time Series Analysis-Curve Fitting-Method Of Least Squares-Testing Of Hypothesis-Chi Square Distribution-Student Distribution F Distribution-Correlation And Regression Analysis.

3) Computational Techniques:

Solution Of Non-Linear Equations (Newton-Raphson Method)-Regular Falsie Method-Solution Of Linear Equations (Gauss Elimination Method With Pivoting, Gauss-Seidel Iterative Method)-Differential Equation –Euler Method (1^{st} Order)- Runge-Kutta Method (2^{nd} And 4^{th} Order)

Part-II: Software Tools

1) C++ For Physicists:

An Overview Of C++ - Introducing Classes-A Closer Look At Classes-Operators, Array, Pointers And Reference

2) MATLAB For Physicists:

Problem Solving Using The Technique Developed In Part-I

Part–III: Experimental Tools

Advanced Experiments In Physics:

1. Solubility Studies
2. Crystal Growth: Gel Methods

3. Crystal Growth: Solution Methods(Slow Evaporation/Slow Cooling)
4. Crystal Growth: Bridgman Apparatus
5. Crystal Structure Analysis: Powder XRD
6. Micro Hardness Study: Indenter
7. Absorption/Transmission: UV-Spectrophotometer
8. Dielectric Constant: LCR Meter
9. Photoconductivity
10. Electrical Conductivity: Four Probe Method
11. Hall Coefficient: Hall Probe
12. Spectral Analysis: FTIR
13. Compressibility Of Liquids: Ultrasonic Interferometer
14. Doping Analysis: Atomic Absorption Spectrum
15. Programs In C++ For The Computational Technique Learned
16. Use Of MATLAB (Of Similar Software) For The Mathematical Technique Learned

Books for Study:

1. Schaum's Outline Series-Theory And Problems Of Vector Analysis And An Introduction To Tensor Analysis-Murray R. Spiegel, Tata McGraw Hill., 2004
2. Vector And Tensor Analysis-Harry Lass, Tata McGraw Hill
3. Laplace and Fourier transform- Goyol Gupta, Pragati aprakasan
4. Schaum's Outline Series-Statistical 3rd edition-Murray R. Spiegel, Tata McGraw Hill., 2004
5. Statistical method for research workers-cosmo publication 2006
6. Numerical methods and C++ programs books
7. Numerical methods and MATLAB programs books

PH 1157: Advances In Material Sciences

Paper III

Part – 1: Techniques

Semester: I Credits: 6
Course: Elective Subject Hours/Week: 6

Unit 1: The Technology Of Epitaxy Advantages Of Epitaxy Growth-Epitaxial Techniques Liquid Phase Epitaxy-Apparatus Tipping, Dipping, Sliding-Principles Of Lpe Growth Vapour–Phase Epitaxy Principles-Operation Technology-Mocve, Lbe ,Cbe, Ale-Quasi Crystals/Quasocrysatillane State –High Dimensional Crystallography ,Sample Characterization ,Modelling The Atomic Structure Of Crystals , Phase Transformation.

Unit 2: Nanopowders and Nanomaterials And Nanoelectronics-Preparation Techniques-Application Of Nanomaterials-Carbon Age –Types Of Nanotubes-Formation Of Nanotubes –Carbon Nanotubes-Properties And Uses Of nanotubes Optics ,Photonics –Interaction Of Light And Nano Materials –Photon Trapping And Plasmons-Dielectric Constant And Polarization-Refractive Index- Nanoelectronics –Tools Of Micro And Nanofabrication-Optical Lithography-Electron Beam Lithography –Atomic Beam Lithography-High Electron Mobility-Carbon Nanotubes Transistors –Future Applications.

Unit 3: Thin Film Applications- Material Selection Design And Fabrication Of Thin Film Register, Capacitor ,Diode, Transistor, Transparent Conducting Oxide Thin Films –Semi Conducting Thin Films –Thin Film Solar Cell –Cds And Cu2s Based Solar Cells Cds-Cu2s And Cds/Culnse2 Solar Cell – Thin Film Mask Blank For Vlsi- Thin Film Sensors For Gas Detection-Thin Film Deposition Techniques –Characteristic Studies.

Unit 4: Laser Principles And Applications –Fiber Optics –Application –Raman Spectroscopy-Ultrasonic Means Of Communication-Non-Destructive Testing –Dispersive And Colloidal Effects Of Ultrasonic –Separation Of Mixtures By Ultrasonic Cutting And Machinery Of Hand Materials –Applications.

Unit 5: Instrumental Analysis-Differential Scanning Calorimeter (DSC)-Electron Energy Loss Spectroscopy (EELS)-Scanning Electron Microscopy (SEM)-Transmission Electron Microscopy (TEM)-Atomic Force Microscopy (AFM)-Scanning Tunneling Microscopy (STM)-Reflection Electron Microscopy (REM)-Crystallographic Analysis in the HR-TEM of TEM-Convergent Beam Electron Diffraction Analysis (CBED) Application-Photoluminescence (PL) Spectroscopy-Plasma Emission (PE) Spectroscopy Applications.

Book for reference:

1. Brice J. C. (1986), ‘Crystal Growth Process’, John Wiley and Sons, New York.
2. Brice J.C. (1973), ‘The growth of crystals from liquids’, North Holland publishing company, Amsterdam.
3. Buckley H.E. (1951), 'Crystal Growth', John Wiley and Sons, New York. Pamplin B.R. (1980), ‘Crystal Growth’, Pergman Press, London. Henisch H.K. (1988), ‘Crystals in gels and Liesegang rings’, Cambridge Univ. Press. USA
4. R.T. Sane and Jagdish K Ghadge ‘Thermal Analysis Theory and applications’ Quest Publications 1997
5. V G Dmitriev, G.G. Gurzadyan, D.N. Nikigosyan; ‘Handbook of Nonlinear optical crystals’ Springer-Verlag 1991
6. Joshi V.N. (1990), ‘Photoconductivity’, Marcel Dekker, New York. Santhanaraghavan P. and Ramasamy P. Crystal growth Process and Methods, (2000) KRU Publications, Kumbakonam.