DEPARTMENT OF PHYSICS

M.PHIL PHYSICS

M.PHIL PROGRAMME

SYLLABUS

Effective from the Academic Year 2016-2017

Loyola College (Autonomous)

Chennai- 600 034

DEPARTMENT OF PHYSICS

M.Phil. Restructured Syllabus

(Effective from 2007-08)

Total Credits : 36

Semester	Nature	Code	Course Title	Credits
I	MC	PH 1117	Quant. F.Theory & Cond. Matt. Phys.	6
	MC	PH 1118	Techniques & Tools for Physicists	6
	ES	PH 1157	Advances in Material Science	6
II	MC	PH 1217	Dissertation & Viva Voce	18

PH 1117 : QUANTUM FIELD THEORY AND CONDENSED MATTER PHYSICS

Paper - I

Semester I — Credits : 6

Course : Major Core (MC) — Hours/week : 6

Unit - 1 : Dirac equation and spin of the electron : Place 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 - canoncial coordinates for the fields - Real scalar field complex scalar field Schroedinger's field - Firac field - Maxwell's field - Froca's field.

Unit 2 : Quantization of real scalar field : Classical radiation field - creation. annihilation and number operators - Quantized radiation field - Emission and absorptionof photons by atom - dipole approximation - Rayleign scattering. Thomson scattering and the Raman effect.

Unit - 3 : Single Particle Approximation : The Hartree and Hartree - Fock approximation - Hartree - Fock theory of free electrons - Density functional theory.

Electrons as quasi particles : Quasi particles and collective excitations - Thomas Fermi screening

Electrons in periodle potentional : Bloch states - k-space Brillouin zones dynamic & crystal electrons - crystal symmetries beyond periodicity - symmetries of the band structure - symmetries of 3D crystals.

Unit 4 : Band structures of crystals : The tight binding approximation - Pseudopotential method. Band structure (B.S.) of a semimetal - graphite (2D solid) B.S. of semi conductors and insulators. (3D covalent solids) B.S. of metallic solids.

Applications of band theory : Density of states - tunneling at metal - semi conductor contact - optical excitations - conductivity and dielectric function. Excitons : Energetics and dynamics : Total energy - Forces and dynamics

Unit - 5 : Magnetc behaviour 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 antl 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 - Efthimios Kaxiras, Cambridge University., 2003
4. Solid State Physics. Structure and properties of Materials - M.A., Wahab, Narosa Publishing House Pvt. Ltd., Second Edition, 2005

Books for reference :

1. Solid State Physics - Aschcroff and Mermin, Harcourt College Publishers., 2001
2. Solid State Physics - S. Rogalsk and B.Palmer Gercon and Breach Science Publishhers., 2001
3. Solid State Physics - Ajay Kumar, Saxema, Macmillan Publishers., 2006
4. Relativistic Quantum mechanics - Bjorken and Drell., 2005

PH 1118 : TECHNIQUES & TOOLS FOR PHYSISISTS

Paper - I I

PART - I TECHNIQUES

Semester I — Credits : 6

Course : Major Core (MC) — Hours/week : 6

i) Mathematical Techniques :

a. Tensor Analysis : Physical laws - 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 fields - symmetric and skew - symmetric tensors-Funcamental operations with tensor.

b. Finite Fourier Transforms : The finite Fourier sine and cosine transforms - Fourier integral theorem - Parsevals' identity - Problems related to Fourier integral.

ii) Statistical Techniques :

Elementary ideas of Probability distributon - 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.

iii) Computational Techniques :

Solution of Non-linear equations (Newton-Raphson method,) Regular Falsi method) - Solution of Linear equations (Gauss elimination method with pivoting, Gauss - Siedel Iterative method) - Differential equations - Euler method (1st order) Runger - Kutta method (2nd and 4th orders)

PART - 2

SOFTWARE TOOLS

i) C++ for Physicists

An overview of C++ - Introducing Classes - A closer look at Classes - Arrays, Pointers and Reference

ii) MATLAB for Physicists :

Problem solving using the techniques developed in Part 1

PART - 3

EXPERIMENTAL TOOLS

Advanced Experiments in Physics

1. Solubility Studies
2. Crystal growth: Gel method
3. Crystal growth: Solution method (slow evaporation / slow cooling)
4. Crystal growth : Bridgman Apparatus
5. Crystal Structure analysis: Powder XRD
6. Microhardness 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 (or similar software) for the mathematical techniques 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 Transforms - Goyal Gupta, Pragati Prakasan
4. Schaum's Outline Series - Statistics - 3rd Edition, Murray R Spiegel and Larry J Stephens, Tata McGraw Hill., 2004
5. Statistical Methods for Research Workers - Cosmo Publications., 2006
6. Numercial Methods -S. Balachandra Rao and C.K. Shantha, Universits Press., 2004
7. Teach yourself C++ - 3rd edition, Herbert Schildt, Tata McGraw Hill., 2002
8. Technical Reference manual of MATLAB
9. Technical Reference manuals of all the equipments of the experiments listed in Part - 3

PH 1157 : ADVANCES IN MATERIAL SCIENCE

Paper - III

PART - I TECHNIQUES

Semester I — Credits: 6

Category : Elective Subject — Hours/week: 6

Unit 1: The technology of epitaxy advantages of epitaxial growth - epitaxial techniques liquid phase epitaxy - apparatus tipping, dipping, sliding - principles of LPE growth vapour - phase epitaxy principles - operation technology - mocvd, lbe, cbe, ale-quasi crystals / quasicrystalline 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 registor, capacitor, diode, transistor, transparent conducting oxide thin films-sem conducting thin films-thin film solar cell-Cds and Cu_2S based solar cells CdS-Cu_2S and cds/CuInSe2 solar cells-thin film mask blanks for VLSI-thin film sensors for gas detection-thin film deposition techniques - characteristic studies

Unit 4 : Laser principles and applications-fiber optics - applications - 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) Electronenergy loss spectroscopy (EELS), SIMS-Scanning Electron Microscopy (SEM)-Transmission Electron microscopy (TEM)-atomic force microscopy (AFM)-Scanning Tunneling Microscopy (STM) Reflection Electron Microscopy (REM)-crystallographic analysis in the TEM - HRTEM - Convergent Beam Electron Diffraction analysis (CBED) applications - photoluminescence spectroscopy-plasma emission spectroscopy-applications.

References

1. Crystal growth processes and method - P.Santhana Ragavan and P.Ramasamy KRU publications., 2005
2. Nanotechnology - Basic science and emerging technologies - Mick Wilson, Kamali Kannangara, Geoff Smith, Michelle Simmons, Burkhand Raguse - Overseas Press India Pvt. Ltd., 2005
3. Handbook of thin film technology - L.I. Maissel and R.Glang, Mc Graw Hill New York., 1970
4. Thin film phenomena - K.L. Chopra Mc Graw Hill, New York., 1990
5. Physics of thin films, George Hans Vol. 12 Academic Press New York
6. Quasi crystals: quasicrystalling order, atomic structure and phase transition by Pierre Guyot, Marc de BOISSIEU and Marc Audier Laoortaire de thermodynamic que et physio chimmie metallurgiques
7. Instrumental analysis 5th edition - Skoog, Holider Nieman
8. Workshop on Crystallographic Techniques in Transmission Electron Microscopy CTTEM - Seminar proceedings - IGCAR (Kalpakkam)., 1994
9. National Science Day Publication, Dept of Physics, Loyola, Chennai
10. Practical Non Destructive Testing - Baldev Raj, T.Jayakumar M.Thavasimuthu, Narosa Publishing House - Chennai., 1997