

CIRCULAR:-

A reference is invited to the Ordinances, Regulations and syllabi relating to the M.Phil degree course vide Pamphlet No.180 and to this office Circular No.UG/83 of 2007 dated 8th March, 2007 and the Head of the University Department of Physics and the Principals of the affiliated colleges in Science are hereby informed that the recommendation made by the Board of Studies in Physics at its meeting held on 3rd February, 2007 has been accepted by the Academic Council at its meeting held on 9th February, 2007 vide item No.4.41 and that in accordance therewith the syllabus for M.Phil degree course in the subject of Physics is revised as per Appendix and that the same has been brought into force with effect from the academic year 2006-2007.

MUMBAI-400 032
9th April, 2007

for I/c REGISTRAR

To,

The Head of the University Department of Physics and the Principals of the affiliated colleges in Science.

A.C/4.41/09.02.2007

No.UG/140 -A of 2007, MUMBAI-400 032 9th April, 2007.

Copy forwarded with compliments for information to :-

- 1) The Dean, Faculty of Science
- 2) The Chairman, Board of Studies in Physics.

for I/c REGISTRAR

Copy to :-

The Director, Board of College and University Development, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Personal Assistant, the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar Administrative sub-center, Ratnagiri for information.

The Officer on Special Duty and Controller of Examinations (10 copies), the Finance Accounts Officer (2 copies), Record Section (5 copies), Publications Section (5 copies), Deputy Registrar, Enrolment, Eligibility and Migration Section (3 copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (2 copies), Deputy Registrar, Affiliation Section (2 copies), the Director, Institute of Distance Education (10 copies), the Director University Computer Center (IDE Building), Vidyanagari, (2 copies), Deputy Registrar (Special Cell), the Deputy Registrar, (PRO), the Assistant Registrar, Academic Authorities Unit (2 copies) and the Assistant Registrar, Executive Authorities Unit (2 copies). They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above Circular and that the same will be sent in this form.

UNIVERSITY OF MUMBAI



Revised Syllabus
for
M.Phil.degree course
in Physics

(with effect from the academic year 2006-2007)

University of Mumbai

Revised Syllabus

M.Phil. Degree Course in Physics (November 2006 onwards)

1. Structure of the course:

The M.Phil. Degree programme in Physics is 1½ years full time course consisting of Theory course of one year duration and Dissertation work of six months duration. There are Three Theory Papers of 100 marks each. The first two theory papers are compulsory and common to all students. The third paper is optional and it consists of two modules. The details of the theory papers are as follows:

Paper I: Research Methodology and Computational Methods of Physics (80 Lectures)

Paper II: Methods of Experimental Physics and Instrumentation (80 Lectures)

Paper III: Optional -Any two modules from the following: (80 Lectures)

Module 1. Theoretical Physics (40 Lectures)

Module 2. Condensed Matter Physics (40 Lectures)

Module 3. Semiconductor Physics (40 Lectures)

Module 4. Modern Electronics (40 Lectures)

Module 5. Nanotechnology (40 Lectures)

Module 6. Accelerator Physics (40 Lectures)

Module 7. Nuclear Physics (40 Lectures)

Module 8. Laser and Plasma Physics (40 Lectures)

Module 9. Materials Science (40 Lectures)

2. Detailed Syllabus:

Paper I: Research Methodology and Computational Methods of Physics (80 Lectures)

Section I: Research Methodology

1. Principles of Scientific Research: Identification of the problem, Assessing the status of the problem, Guidance from the supervisor. Actual investigation, Determining the mode of attack,

2. **Literature survey:** References, Abstraction of a research paper, Possible ways of getting oneself abreast of current literature,
3. **Internet and its application:** E-mail, WWW, Web browsing, Acquiring technical skills. Drawing inferences from data,
4. **Qualitative and Quantitative analysis:** Results and Conclusions, Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar, Thesis writing.

Main References:

1. Thesis & Assignment Writing—J Anderson, B.H.Dursten & M.Poole, Wiley Eastern, 1977
2. A Hand Book of Methodology of Research – P. Rajammal and P. Devadoss, R. M. M. Vidya Press, 1976.

Section II: Computational Methods of Physics

1. **Fundamentals of Scientific Programming Languages**
2. **Basic Numerical Techniques:** interpolation, differentiation, integration, fitting, root finding.
3. **Ordinary and Partial Differential Equations:** Euler and Runge-Kutta methods, initial-value, and eigenvalue problems.
4. **Monte Carlo Simulations:** Random number generators, multi-dimensional integrals, many-body systems, Ising model.
5. **Applications:** Use of Computational techniques to some standard Physical systems.

Main References:

1. Computer Applications in Physics with FORTRAN, BASIC and C; Second Edition, Suresh Chandra, Narosa Publishers, 2006
2. Computer Programming in Fortran 90 and 95 by V.Rajaraman, Prentice Hall India, 2004.
3. Scientific Computing in Fortran and C by William Press, Oxford University Press, 1999

Section I: Basic Measurements

- 1) **Evaluation of Measurements:** Errors; Normal, Binomial and Poisson distribution; Least square fit; Curve, fitting, Polynomials; Chi-square test.
- 2) **Length and Related Quantities:** Rutherford Experiment (Nuclear Size); X-ray, Electron and Neutron diffraction (Atomic size).
- 3) **Voltage, Current and Charge Measurements**
- 4) **Magnetic Field:** Magnetic Materials; Production and Measurement of Magnetic Fields.
- 5) **Temperature:** Production and Measurement of High and Low Temperatures, High temperature materials.

Section II: Experimental Methods

1. **Vacuum Technology:** Production and Measurement of Rough to Ultra High Vacuum; Design of vacuum systems; Leak detection methods. Vacuum Materials.
2. **Thin Film Technology:** Synthesis of thin films for research and technological applications.
3. **Ion Beam Techniques:** Synthesis, Modification and Processing of novel Materials: Ion beam analysis- SIMS, RBS, Channeling, ERDA.
4. **Modern Analytical Tools:** AES, XPS, TEM, SEM, FTIR spectroscopy, Raman spectroscopy, ESR, PL, STM, AFM.
5. **Great Experiments in physics:** Any two great experiments suggested by the teacher concerned not covered in the syllabus.

Main References:

1. "Errors of Observation and their Treatment" by J. Topping. Chapman of Hall, London 1972.
2. B.D. Cullity, "Elements of X-ray diffraction", Addison-Wesley Publishing company inc., 1977.
3. "Methods of Experimental Physics Vol. 2" by L. Marton (ed), Academic Press, New York, 1981.

4. "Introduction to Magnetic Materials" by B. D. Cullity, Addison Wesley Publishing Company, 1974.
5. "Temperature" by T. J. Quinn, Academic Press, London, 1983.
6. "Vacuum Technology" by A. Roth, North Holland, Amsterdam, 1982.
7. K.L. Chopra, Thin film phenomena, Mc-Graw Hill, New York, 1969.
8. "Ion Implantation" by G. Dearnaley, J. H. Freeman, R. S. Nelson, and J. Stephen, North-Holland, Amsterdam, 1973.
9. L. C. Feldman and J.W. Mayer, Fundamentals of surface and Thin Films Analysis, North Holland, Amsterdam, 1986.
10. Great Experiments in Physics, M. H. Shamos, Dover Publication, 1987

Additional References:

1. "An Introduction to Experimentation" by E. Rabonowicz, Addison – Willy Publishing Co, 1970
2. "Laboratory Magnetism" by D. J. Kroom, Philips Technical Library, 1968.
3. "Experimental Methods in Magnetism Vol. IX" by H. Zijlstra, North Holland, Amsterdam, 1967.
4. "Physics of Magnetism" by S. Chikazumi & S. H. Charap, John Wiley, New York, 1964.
5. "Experimental Techniques in Low Temperature Physics" by G. K. White, Oxford, 1968.
6. "Low Temperature Laboratory Techniques" by A. C. Rose Innes, The English University Press, London, 1973.
7. "High Temperature Material and Technology" by I. E. Campbell and E. M. Sherwood, John Wiley, New York, 1967.
8. "Theory & Practice of High Vacuum Technology" by L. Ward & J. P. Bunn, Butterworths, London, 1967.
9. "Design & construction of small vacuum systems" by G. W. Green, Chapman & Hall, London, 1968.
10. Ludmila Eckertova, Physics of thin films, 2nd Revised edition, Plenum Press, New York, 1986 (Reprinted 1990).
11. "Ion Beams with Applications to Ion Implantation" by R. G. Wilson and G. R. Brewer, John Wiley, New York, 1973.

12. "Low Energy Electrons and Surface Chemistry" by G. Ertl and J. Kupperts, Weinheim, 1974.
13. "Practical Surface Analysis by Auger and X-ray Photoelectron spectroscopy" by D. Briggs & M. P. Seah, John Wiley, Chichester, 1983.

Paper III: Optional Paper

(80 Lectures)

N.B. Any two modules from the following:

Module 1. Theoretical Physics (40 Lectures)

This paper is envisaged as applications of Quantum Mechanics to physical systems through problems:

1. Formalism in quantum mechanics,
2. Time dependent perturbation theory,
3. Relativistic Quantum Mechanics,
4. Scattering Theory

Main References:

1. Richard Liboff, *Introductory Quantum Mechanics*, 4th ed., 2003.
2. Ajoy Ghatak and S Lokanathan, *Quantum Mechanics: Theory and Applications*, 5th ed., 2004. (GL5)
3. W. Greiner, *Quantum Mechanics: An Introduction*, 2nd ed., 2001.
4. R. Shankar, *Principles of Quantum Mechanics*, 2nd ed., 1994
5. L.I Schiff, *Quantum Mechanics*, 1968
6. Claude Cohen - Tannoudji, Bernard Diu, Frank Laloe, *Quantum Mechanics Vol I and II*, 1977
7. C.S. Johnson and Pederson, *Problems and solutions in Quantum Chemistry and Physics*, 1974
8. S. Flugge, *Practical Quantum mechanics*, 1971
9. W. Greiner, *Relativistic Quantum Mechanics*, 2nd Ed., 2001
10. J.J. Sakurai, *Advanced Quantum Mechanics*, Addison Wesley, 1967

Module 2. Condensed Matter Physics (40 Lectures)

1. **Physical applications of Group theory in crystals:** Theory of group representation, crystal symmetry operators; Crystallographic point groups. Representation of three dimensional rotation group. Crystal field splitting and other related problems.
2. **Elastic Scattering of waves:** Interference of Waves, Elastic scattering by Crystals, Experimental Techniques, Scattering from surfaces, Scattering from amorphous solids
3. **Magnetic Properties:** Background, Diamagnetism and Para magnetism, Ferromagnetism, Ferri and anti ferrimagnetism, Spin waves, Magnetic resonance Phenomenon

Main References:

1. M. Tinkham, Group Theory and Quantum Mechanics. Dover Publications, 2003
2. N.W.Ashcroft and N.D. Mermin, Solid State Physics. Brooks Cole, 1976
3. J. Richard Christman, Solid State Physics. John Wiley, 1988

Module 3: Semiconductor Physics (40 Lecture)

1. **Crystal structure and Band structure:** Study of crystal structure and band structure of silicon, germanium and gallium arsenide semiconductors.
2. **Properties of Semiconductors.** Charge carriers in semiconductors, Hall Effect; Magneto resistance; Hot carriers; Quantum Hall effect. Thermal effects in semiconductors. Fundamental, impurity, free carrier and exciton absorption. Radiative and surface recombination. Photoconductivity. Optical processes in quantum wells; Laser action in semiconductors.
3. **Advanced and Novel Electronic Materials:** Amorphous Si, Ge and GaAs, Organic semiconductors, Spintronics materials, Dilute magnetic semiconductors; Semiconductor quantum wells, quantum wires and quantum dots; Semiconductor nanocrystals.
4. **Surfaces and Interfaces:** Surface states. Interface states in semiconductor devices; Characterization of semiconductors and devices by I-V, C-V, G-V and DLTS techniques.

5. **Ultra Large Scale Integrated circuit (ULSI) device technology:** Semiconductor bulk crystal Growth, Epitaxy, defects, dislocations and doping in semiconductors, Basic device fabrication processes, Circuit design and fabrication.

Main References:

1. R.A. Smith, Semiconductors, 2nd edition; Cambridge University Press, London, 1978.
2. Jasprit Singh, Physics of Semiconductors and their Heterostructures, McGraw-Hill, New York, 1993,
3. M.H. Brodsky (ed), Topics in Applied Physics Vol.36, Amorphous Semiconductors,
4. S.R. Elliott, Physics of Amorphous Materials, Longman, London, 1983,
5. E.L. Wolf, Nanophysics and Nanotechnology, Wiley-VCH Verlag, Weinheim, 2004.
6. S.M. Sze, Physics of Semiconductor Devices, John Wiley, N.Y., 1981,
7. E.H. Nicollian and J.R. Brews, MOS Physics and Technology, John Wiley, 1982,
8. S.M. Sze, Semiconductor Devices-Physics and Technology, John Wiley, 1985

Additional References:

1. Aldert van der Ziel, Solid State Physical Electronics, 2nd edition, Prentice-Hall, New Delhi, 1971,
2. S.Y. Wang, Introduction to Solid State Electronics, North Holland, 1980.
3. J.I. Pankove, Optical processes in semiconductors,
4. J. Singh, Semiconductors, Optoelectronics, Mc-Graw Hill,
5. S.K. Ghandhi The theory and practice of Microelectronics, John Wiley and Sons.
6. S.M. Sze, VLSI Technology, Mc Graw Hill Book, N.Y., 2nd Ed
7. S.K. Ghandhi, VLSI fabrication principles, John Wiley, N.Y., 1983

Module 4. Modern Electronics (40 Lectures)

1. **Microcontroller:** Introduction to microcontroller, 8051 microcontroller, MCS-51 Architecture, Registers, 8051 pin description, Connections, I/O ports, Memory organization, Addressing modes, Instruction set, Stack pointer, 8051 Assembly language programming, Development systems and Tools, Software

simulator of 8051, Interrupts, Timer and Counter, Serial communication, Atmel microcontrollers (89C51 / 89C2051), Architectural overview, Pin description (89C51 / 89C2051), Applications of MCS – 51 and 89C51 / 89C2051, PIC microcontroller – overview, Memory organization and Instructions, Addressing modes, I/O ports, Interrupts in PIC 16C61/71, PIC 16C61/71 timers, PIC 16C61/71 – ADC, PIC 16F8XX flash microcontroller, Interfacing and microcontroller applications, Industrial applications of microcontrollers.

2. **VHDL:** Basic terms in VHDL, Behavioral modeling, Types of delay, Sequential processing, Data types, Function and Procedure, Attributes, Configurations
3. **Embedded system:** Introduction to embedded system. Design challenges, Optimizing design metrics, Processor design and IC technology, Embedded system project management, Embedded system design and co-design issues in system development process, Design cycle in the development phase for an embedded system. Use of software tool for development of embedded system
 PC interfacing: Study of PC parallel port: Essentials. Accessing ports, Programming issues. Programming tools, Experiments and interfacing, Study of PC serial port: Format and Protocol, Sending serial Data. Transmitting a byte, Data Formats, Preventing missed data, Port architecture. Port resources. Configuring inside the UART.

Main References:

1. Microcontrollers – Theory and Applications. Ajay V Deshmukh. Ch. 1 to 10, 12,13.
2. VHDL Programming by example, Douglas L. Perry. Ch. 1 to 7.
3. Embedded system design – a unified hardware. software introduction Frank Vahid and Tony Givargis Ch.1.
4. Embedded system design – Raj Kamal. Ch. 12.1 to 12.3. 12.5
5. Parallel port complete – Jan Axelson. Ch. 1 to 6
6. Serial port complete -- Jan Axelson. Ch. 2,3

Module 5. Nanotechnology (40 Lectures)

1. Fundamentals of nanomaterials and nanostructures
2. Synthesis of nanoparticles, nanoclusters, nanocrystals; top-up approach and bottom-up approach, Self-Assembly.
3. Properties of Metal Nanoclusters, Semiconducting Nanoparticles, Rare Gas and Molecular Clusters and Nanotubes.
4. Characterization of nanomaterials and nanostructures: structure, particle size, distribution.
5. Applications of nanotechnology in Semiconductor devices, Energy, Sensors, Coatings.

Main References:

1. Introduction to Nanotechnology, C. P. Poole and F. J. Owens Pub Wiley & Sons, 2006
2. Nanostructures & Nanomaterials, Synthesis Properties & Applications, G. Cao, Imperial Press 2006
3. Springer Handbook of Nanotechnology. Bharat Bhushan, 2004

Module 6. Accelerator Physics (40 Lectures)

1. Introduction to Accelerators; Types of Accelerators: High voltage dc and r. f. accelerators, Cyclotron, Betatron, Synchrotron and Linear accelerators, Van de Graaff generator, Tandem accelerator, Pelletron accelerator.
2. Ion Sources: Freeman ion beam source, Penning ion source, Sputtered ion source, Duoplasmatron ion source, Negative ion beam sources, Electron Cyclotron Resonance (ECR) ion beam sources, LASER ion source. Beam switch yard: conventional magnet and superconducting magnet Beam optics. Beam profile monitor, Faraday cup, Quadrupole. Accelerator driven systems: Injection and extraction, Vacuum systems.
3. Application of accelerators: Ion implantation. Surface modifications and research. Materials analysis. Nuclear physics, High energy Physics studies, Production of medical isotopes, Radiotherapy. Radiation and Safety.

Main References:

1. S Y Lee, Accelerator Physics, [World Scientific 1999]
2. Edmund Wilson, An Introduction to Particle Accelerators. [Oxford University Press 2001]
3. Alex Chao, Handbook of Accelerator Physics and Engineering [World Scientific 1999]
4. Mario Conte and William W McKay, An Introduction to the Physics of Particle Accelerators, [World Scientific 1991]
5. Ashok Das and Thomas Ferbel, Introduction to Nuclear and Particle Physics [John Willey 1994]
6. J.F. Ziegler, Ion Implantation Science and Technology.
7. G. Dearnaley, J.H. Freeman, R.S. Nelson, and J. Stephen, Ion implantation, North Holland, Amsterdam 1973.

Module 7. Nuclear Physics (40 Lectures)

- 1 Nuclear Structure: Problem of Nucleon –Nucleon Interactions and Nuclear Forces. Nuclear Models and Nuclear Matter, Electromagnetic and Weak Interactions with Nuclei.
- 2 Nuclear Reactions: Formal theory of Scattering and Nuclear Reaction Mechanisms. Compound Nuclear Reactions, Optical Model and Direct Nuclear Reactions, Nuclear Reactions at Intermediate and High Energies.
- 3 Methods in Experimental Nuclear Physics

Main References:

1. Nuclear structure. M. A Preston and R. K. Bhandhuri, Addison – Wesley (1975).
2. Nuclear Physics: R. Roy and B. Nigam – Wiley Eastern Ltd. (1979).
3. Fundamentals of Nuclear Physics – N. A. Jelly, Cambridge University Press.
4. Introductory Nuclear Physics – Samuel S. M. Wong, Prentice Hall of India(1996).
5. Nuclear models. Greiner and Maruhn: Springer Verlag.
6. Nuclear Reactions—Daphne F. Jackson ,Chapman and Hall.
7. Nuclear and Particles – E. Segre
8. Nuclear Physics, H A Enge

9. Techniques for Nuclear and Particle Physics Experiments, W.R.Leo, Springer – Verlag, II edition.

Module 8. Laser and Plasma Physics (40 Lectures)

1. **Fundamentals of Laser:** Laser Raman Spectroscopy, Holography, New Developments in Spectroscopy, Applications.
2. **Fundamentals of Plasma:** Magnetohydrodynamics (MHD), Space Plasma Physics, Transport properties in Plasma, Applications.

Main References:

1. Lasers: Theory & Applications, A.K.Ghatak
2. Optoelectronics Devices & Systems, S.C.Gupta
3. Space Plasma Physics, A.C.Das
4. Laser Spectroscopy, W.Demtroder(Springer)
5. Introduction to Plasma Physics & Controlled Fusion, F.F.Chen
6. The Physics of Laser & Plasma Interactions, W.L.Kruer
7. Industrial Plasma Engineering, J.Reece,Roth
8. Introduction to Plasma Theory, D.R.Nicholson
9. Plasma Physics, R.Dendy

Module 9. Materials Science (40 Lectures)

1. *Introduction to Materials Science:* Classification of Materials, Functional Classification of Materials, Classification of Materials Based on Structure, Environmental and Other Effects, Materials Design and Selection.
2. *Atom and Ion Movements in Materials:* Applications of Diffusion, Stability of Atoms and Ions, Mechanisms for Diffusion, Activation Energy for Diffusion, Rate of Diffusion (Fick's First Law), Factors Affecting Diffusion, Permeability of Polymers, Composition Profile (Fick's Second Law), Diffusion and Materials Processing, Chemical Equilibrium, Rate of Reaction, First and Second order Phase Transformation, Order-Disorder Transformation, Solid State Sintering.
3. *Solid Solutions and Phase Equilibrium:* Phases and the Phase Diagram, Solubility and Solid Solutions, Conditions for Unlimited Solid Solubility, Solid-
