Syllabus

OF

Course Work

for

DOCTOR OF PHILOSOPHY (Ph.D.)

PHYSICS

Choice Based Credit System (CBCS)

DEPARTMENT OF PHYSICS,
VEER NARMAD SOUTH GUJARAT UNIVERSITY,
UDHANA MAGDALLA ROAD,
SURAT -395007 (GUJARAT)

Structure for Ph.D. Syllabus

Ph.D. (PHYSICS)

Sr. No.	Course Code	Course Title	L	T	P	Cr.
1	PH-601	Research Methodology	4	1	0	4
2	PH-602	Numerical and Computational Techniques	4	1	0	4
3	PH-603	Elective – I	4	1	0	4
	(Any One)	Elective – II				
		Elective – III				
			12	03	0	12

Electives:

PH-603 (M) Advanced Materials Science

PH-603 (T) Theoretical Condensed Matter Physics and Nuclear Collision Theory

PH-603 (E) Thin Film, Microelectronics, Linear IC, Microcontroller and Embedded Systems

Effective from June 2018

Faculty of Science **Ph.D. PHYSICS**

DEPARTMENT OF PHYSICS, VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT -395007

Syllabus

Faculty Code: **SCI** Subject (Paper) Code: **PH** Level Code: **04**

Name of Program**: Ph.D.** Subject: **PHYSICS**

Course (Paper) Name & No.: **PH- 601 RESEARCH METHODOLOGY IN PHYSICS**

Course (paper) Unique Code: **PAPER-1** **PH-601**

External Examination Time Duration: **03 Hours**

Name of Exam	Semester	Course Group	Credit	Internal Marks	External Marks	Practical/Viva Marks	Total Marks
Ph.D.	**1**	**Core**	**04**	**50**	**50**	**----**	**100**

Course Objectives:

- **Strengthening Foundations of research methodology in the subject of Physics**
- **To expose the students with the theoretical concepts of Research**

Ph.D. Syllabus 2018
PH-601
PH-601 Research Methodology

UNIT : 1 Research Methodology : An Introduction, meaning, objectives and purpose of research. Types of research, significance and characteristics of research, criteria of good research, Research Methods and methodology, scientific methods, Distinction to scientific Methods.

UNIT : 2 Research process and problems, Research design, Concepts and type of research design, important of Experimental design and limitation of research. Data collection and its Analysis.

UNIT : 3 Report writing ,Structure of scientific report, Types of report, Significance of the report, characteristics of repot, report heading and body of the report, References/Bibliography.

UNIT : 4 Research evaluation methods, various index (h-index, I-index, etc…) index and abstracting service and their calculations. Plagiarism, its significance and effects. Components of IPR, Patent Laws.

Recommended Books

(1) Research Methods of Science, Michael M. Marda, First Edition, (2011), Cambridge University Press, New York.
(2) Research Methodology, C.C. Kothari and Gourav Garg, Third Edition,(2014), New Age International Publication, Delhi.
(3) Probability and Error for Physical Science, S.K. Muthu Orient Lougman, (1982).
(4) Research Methodology, Dr. P.R. Majhi and Dr. P.K. Khatua Himalaya Publication House.

Effective from June 2018

Faculty of Science **Ph.D. PHYSICS**

DEPARTMENT OF PHYSICS, VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT -395007

Syllabus

Faculty Code: **SCI Subject** (Paper) Code: **PH** Level Code: **04**

Name of Program**: Ph.D.** Subject: **PHYSICS**

Course (Paper) Name & No.: **PH- 602 Numerical and Computational Techniques**

Course (paper) Unique Code : **PAPER-2 PH-602**

External Examination Time Duration: **03 Hours**

Name of Exam	Semester	Course Group	Credit	Internal Marks	External Marks	Practical/Viva Marks	Total Marks
Ph.D.	**1**	**Core**	**04**	**50**	**50**	**----**	**100**

Course Objectives:

- **To expose the Students with the theoretical concepts of Research**
- **To expose the Students with various mathematical methods for numerical analysis and use of computational tools**

Ph.D. Syllabus 2018
PH-602
PH-602 Numerical & Computational Techniques

UNIT-I: **Curve-Fitting** : Least-square Methods, Spline Methods.
Integration: Simpson's $1/3^{rd}$ rule, Romberg intefration, Richardson extrapolation techniques.
Ordinary Differential equation: Euler method, 2^{nd} and 4^{th} order Runge-Kutta Methods.

UNIT-II: **Computer Programming** : Review of FORTRAN-77 through problems.
Introduction to FORTRAN-90: additional features different from FORTRAN 77.
Introduction to parallel computing: Essentials of parallel computation; need for high speed computing and parallel computers.
Introduction to FORTRAN-95: features for parallel computing, FORALL. etc.

UNIT: III **Software Package: Mathematica**
Introduction: Notebook Interfaces, Text-Based Interfaces
Numerical calculations: Arithmetic, Exact and Approximate Results, Some Mathematical Functions, Arbitrary-Precision Calculations, Complex Numbers, Getting Used to Mathematica, Mathematical Notation in Notebooks
Algebraic calculations: Symbolic Computation, Values for Symbols, Transforming Algebraic Expressions, Simplifying Algebraic Expressions, Advanced Topic: Putting Expressions into Different Forms, Advanced Topic: Simplifying with Assumptions, Picking Out Pieces of Algebraic Expressions, Controlling the Display of Large Expressions, The Limits of Mathematica, Using Symbols to Tag Objects
Symbolic mathematics: Basic Operations, Differentiation, Integration, Sums and Products, Equations, Relational and Logical Operators, Solving Equations, Inequalities, Differential Equations, Power Series, Limits, Integral Transforms, Recurrence Equations, Packages for Symbolic Mathematics, Advanced Topic: Generic and Non-Generic Cases, Mathematical Notation in Notebooks
Numerical mathematics: Basic Operations, Numerical Sums, Products and Integrals, Numerical Equation Solving, Numerical Differential Equations, Numerical Optimization, Manipulating Numerical Data, Statistics

UNIT: IV **Spreadsheets/Worksheets packages:SIGMAPLOT**

Introduction: SigmaPlot at a Glance, New Features in SigmaPlot, Installing SigmaPlot, SigmaPlot Basics, Viewing Toolbars, Positioning Toolbars, Undoing Mistakes, Anatomy of SigmaPlotGfraphs, SigmaPlot Help

Notebook Manager Basics:

Notebook Manager Overview, Opening and Closing Notebooks in the Notebook, Manager Protecting Notebooks, Setting a Password, Working with Sections in the Notebook Manager, Creating New Items in the Notebook Manager, Opening Files in the Notebook Manager

Worksheet Basics: Using the Worksheet Shortcut Menu, Setting Worksheet Display Options, Moving Around the Worksheet, Entering Data into a SigmaPlot Worksheet, Importing Files from Other Applications, Exporting Worksheet Data, Descriptive Statistics for Worksheets, Displaying Worksheet Data, Formatting Worksheets, Cutting, Copying, Pasting, Moving, and Deleting Data, Entering and Promoting Column and Row Titles, Removing Outliers and Other Data, Using Excel Workbooks in SigmaPlot, Additional Features With Excel, Excel Toolbars, Using Transforms on Data in Excel Workbooks, Printing Worksheets, Configuring Printer Settings

Recommended Books:

(1) S.C. Chapra, R.P. Canale, Numerical methods for Engineers, 5th ed.,(2006), McGraw Hill
(2) K. SankarRao, Numerical Methods for Scientists and Engineers, (2001), PHI
(3) V. Rajaraman, Computer Programming in FORTRAN 77, 3rded, (1994), PHI
(4) V. Rajaraman, Computer Programming in FORTRAN 90 and 95, (1994), PHI
(5) V. Rajaraman and C Siva Ram Murthy, Parallel Computers: Architecture and Programming, (2004), PHI
(6) S. Wolfram, Mathematica book, 5th ed. (2003).
(7) SIGMAPLOT 11.0 users guide, systat software, inc, (2008).

Effective from June 2018

Faculty of Science **Ph.D. PHYSICS**

DEPARTMENT OF PHYSICS, VEER NARMAD SOUTH GUJARAT UNIVERSITY, SURAT -395007

Syllabus

Faculty Code: **SCI Subject** (Paper) Code: **PH** Level Code: **04**

Name of Program**: Ph.D.** Subject: **PHYSICS**

Course (Paper) Name & No.: **PH- (M)-603/PH- (T)-603/PH- (E)-603**

Course (paper) Unique Code: Elective**-I/Elective-II/Elective-III,**
PH- (M)-603/PH- (T)-603/PH- (E)-603

External Examination Time Duration: **03 Hours**

Name of Exam	Semester	Course Group	Credit	Internal Marks	External Marks	Practical/Viva Marks	Total Marks
Ph.D.	**1**	**Elective-I**	**04**	**50**	**50**	**----**	**100**
		Elective-II					
		Elective-III					

Course Objectives:

- **Introducing thrust areas of research of the Department**
- **Fundamental course on prerequisites for higher studies in Materials Science, Theoretical Physics and Electronics**

Ph.D. Syllabus 2018
ELECTIVE –I
PH-603 (M) Advanced Materials Science

Unit –I Materials Science and Civilization,Classification of Engineering Materials, Modern materials needs,Metals and Alloys, Semiconductors, Ceramics, Composites, Quantum Dots,Spintronics, Nanomaterials, Biomaterials, Biophysics,Origin and Evolution of life – Prebiotic Earth, Theories of origin and Evolution of Life, Laboratory Experiments of the Formation of Molecular.

Unit –II Phase Diagram, Basic concepts, one component diagrams, two component diagrams, Solid Solution Phase Diagrams, Eutectic Phase Diagrams, Peritectic Phase Diagrams, Multicomponent diagrams,Spindonal Curves, Practical aspects of Phase diagrams, Applications of phase diagrams, Applications of Phase Diagrams

Unit –III Surface of Crystalline Solids, General features observable on surface, Techniques for the observation of surface, Growth spirals and hillocks. Growth patterns due to dislocations, movement of dislocations, Micromorphology of anisotropic opposite facets. Dissolution Process, .Surface Morphology of crystalline materials

Unit –IV Mechanism of Solidification of Metals, Nucleation, Crystal Growth, Dendrite Growth, Effects of Super cooling or under cooling on critical Radius of Nuclear, Solid Solutions, Hume Ruthera's Rule,

Reference Books:

(1) S.K. Kakani, AmitKakani
Materials Science – New Age International Publishers (2005)
(2) V. Raghavan,Materials Science and Engineering. A First Course (Fifth Edition)
Prentice- Hall of India Publisher – New Delhi (2005)
(3) Manes Ghande, Science and Engineering Materials Vol.3
McMillian Publisher, India (1980)
(4) Materials Science – An Intermediate Text – William F. Hosford
Cambridge University Press.First Edition (2007)
(5) Materials Science and Metallurgy U.C. Jindal,
Pearson, Dorling Kindersely (India) Ltd, First Impresion (2012)
(6) Biophysics – VasanthaPattabhai, N. Gautham, Narosa Publishing House, First Reprint (2003)
(7) KeshraSangwal and RafaelRodrials Trans Tech Publications.
(9) Material Science and Metallurgy, Parashivamurthy K.I.(2012), Pearson DoringKindersely (India) Pvt.Ltd. First Impression

Ph.D.Syllbus-2018

ELECTIVE -II

PH-603(T) :Theoretical Condensed Matter Physics and Nuclear Collision Theory

UNIT: I Density Functional Theory (DFT)

Examples of DFT in Action: Ammonia Synthesis by Heterogeneous Catalysis, Embrittlement of Metals by Trace Impurities, Materials Properties for Modelling Planetary Formation, The Schrodinger Equation, Density Functional Theory—From Wave Functions to Electron Density Exchange–Correlation Functional, Localized and Spatially Extended Functions, Wave-Function-Based Methods, Hartree–Fock Method, Beyond Hartree–Fock, What DFT cannot do, Density Functional Theory in Other Fields,
Periodic Structures, Supercells, and Lattice Parameters, Face-Centered Cubic Materials, Hexagonal Close-Packed Materials, Crystal Structure Prediction, Phase Transformations

UNIT: II DFT Calculations

Reciprocal Space and k Points: Plane Waves and the Brillouin Zone, Integrals in k Space, Choosing k Points in the Brillouin Zone, Metals—Special Cases in k Space,EnergyCutoffs:Pseudopotentials, Numerical Optimization:Optimizationin One Dimension, Optimization in More than One Dimension, What we really need to know about Optimization, DFT Total Energies—An Iterative Optimization Problem Geometry Optimization, Geometry Optimization with Constrained Atoms, Optimizing Supercell Volume and Shape
Importance of Surfaces, Periodic Boundary Conditions and Slab Models, Choosing k Points for Surface Calculations, Classification of Surfaces by Miller Indices, Surface Relaxation, Calculation of Surface Energies, Symmetric and symmetric Slab Models, Surface Reconstruction, Adsorbates on Surfaces, Accuracy of Adsorption Energies, Effects of Surface Coverage

UNIT: III Introduction of Heavy Ion Collisions

Introduction of Heavy ion induced reactions. Classification of Heavy Ion Collisions: Elastic and Inelastic scattering, Nucleon Transfer reactions, Fusion of Heavy Ions.

UNIT: IV Heavy Ion Collision Theory

Heavy-ion potentials, Compound Nuclear Formation in Heavy Ion Collisions, Different Models for Heavy Ion Collisions simulation and calculations: Time dependent HartreeFock Coupled Channel Methods, Classical and semiclassical methods.

Text Book:

(1) Density Functional Theory: A Practical Introduction by David S Sholl and Janice A Steckel

(2) Nuclear Physics-Experimental and Theoretical, H. S. Hans, New Age International Pub. 2001

(3) The Nuclear Many-Body Problem, Peter Ring and Peter Schuck, Text and Monographs in Physics, Springer-Verlag.

Reference Book:

(1) Density Functional Theory of atoms and Molecules by Robert G Parr and Weitao Yang

(2) Materials Modelling using Density Functional Theory: Properties and Predictions by Feliciano Giustino

(3) Proc. Of the Winter College on Fundamental Nuclear Physics, Vol. 2, Ed. K Dietrich, M. Di. Toro, H. J. Mang, World Scientific (1985).

(4) Heavy Ions and Nuclear Structure, ed. B. Sikora and Z. Wilhelmi, Harwood Academic Pub. (1981).

(5) Treatise on Heavy-ion Science, Vol. 3, Ed. D. A. Bromley, Plenum Press, NY (1984).

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ELECTIVE –III

PH-603(E): Thin Film, Microelectronics , Linear IC, Microcontroller and Embedded Systems

Unit-1 Gas flow vacuum system, Vacuum Pump (rotary, Diffusion) Gauges (Pirani, ionization etc.), Theories of Nucleation, Growth Processes, Physical and Crystallography structure of films, and epitaxial growth. Basic device technology, and approximate doping profile across p-n junction, Metal-semiconductor contacts, solar cell, LED and semi conductor Laser

Unit-2 Device Technologies, NMOS, CMOS, ECL, BIFET, BICMOS, BIMOS, CCD, I²LTechnologies,Monolithic Integrated Circuit Fabrication.

Unit-3 Applications of linear Integrated Circuits:
PLL and its applications, Positive and Negative voltage regulators, IC LM series adjustable voltage regulators, LM 380 Power Amplifier, IC 8038 function generator. Binary weighted type DAC, R-2R ladder type DAC Parallel Comparator type ADC, successive approximation type ADC, counter type ADC, Dual slop type ADC.

Unit-4 Comparison of microprocessor and microcontroller, 8051-Architecture, Special Function Registers, Microcontroller programming model, Instruction set, Data transfer Instructions and related Assembly language programs.

Books:

(1) Vacuum Science and Technology V.V.Rao, T.B.Ghosh and K.I.Chopra, Allied Publishers Limited (India).
(2) Vacuum Technology, A. Roth, North-Holland, (1986).
(3) "Hand book of thin film technology" L.I.Maissel and R.I.Glang, McGraw Hill Book Co. New York,(1970).
(4) "The Material Science of Thin Films" M. ohring, Academic press, New York (1992).
(5) Hand Book technologies of Films and Coatings, R.F.Bunshah, Novyes publication, (1996).
(6) Microelectronics J.Millman and A.Grable, McGraw Hills Publication(1987).

(7) Ramakant Gayakwad, Operational amplifier and integrated circuits by PHI learning Publishing Company(2004).

(8) Kenneth J. Ayeala, The 8051 microcontroller, Architecture, programming and application, Penram International publishing (I) Pvt. Ltd.

(9) M.A. Mazidi, Microcontroller and Embedded Systems, Pearson India Publishing Company, Effective from June 2018