JAYARAJ ANNAPACKIAM COLLEGE FOR WOMEN (AUTONOMOUS)

A Unit of the Sisters of St. Anne of Tiruchirappalli

Accredited with 'A' Grade (3rd Cycle) by NAAC

DST - FIST Supported College Since 2015

(Affiliated to Mother Teresa Women's University, Kodaikanal)

PERIYAKULAM – 625 601, THENI DT.
TAMIL NADU.

M. PHIL. PHYSICS
2017 - 2020

DEPARTMENT OF PHYSICS

PROGRAMME OUTCOMES - M. PHIL

PO. NO.	UPON COMPLETION OF THIS PROGRAM THE STUDENTS WILL BE ABLE TO
1.	Reflect critically on their own, with their peers' and synthetic working situations in the light of new concepts and course input.
2.	Identify relevant sources, evaluate them and to use these appropriately in their studies.
3.	Engage in independent study and group/pair work including the presentation of materials.
4.	Relate skills with self management and task achievement, meeting deadlines, problem-solving and metacognitive awareness.
5.	Associate study skill with data collection and researching, digesting, selecting, planning, writing and presenting articles for publication.
6.	Present reports on their findings in the respective category of work to improve their expertise and imbibe practical abilities.

PROGRAMME SPECIFIC OUTCOMES - M.PHIL

PSO. NO.	UPON COMPLETION OF THIS PROGRAM THE STUDENTS WILL BE ABLE TO	PO MAPPED
1.	Build a higher level of understanding in advanced and applied Physics.	PO-1 PO-2
2.	Enhance their computational and problem solving skills.	PO-4
3.	Formulate novel research ideas, explore and interpret their findings.	PO-5 PO-6
4.	Deliver the results through presentations and publications.	PO- 5 PO-6
5.	Equip themselves to prepare and appear for qualifying/competitive examination.	PO- 5 PO-6

M.PHIL COURSE PATTERN (2017-2020)

Sem.	Code	Title of the Paper	Hours	Credits
I	17MPH1C01	Research Methodology	10	8
	17MPH1C02	Advanced Physics	14	12
	17MPH1E3A	Indepth Study - Thin Film Technology	6	-
	17MPH1E3B	Indepth Study - Principles of material science, synthesis and characterization		
	17MPH1E3C	Indepth Study - Solar cell Technologies & Spectroscopic Studies		
	17MPH1E3D	Indepth Study - Physics of Low Dimensional Systems		
	17MPH1E3E	Indepth Study - Properties and applications of Nanomaterials		
		Total	**30**	**20**
II	17MPH2E3A	Indepth Study - Thin Film Technology	-	5
	17MPH2E3B	Indepth Study - Principles of material science, synthesis and characterization		
	17MPH2E3C	Indepth Study - Solar cell Technologies & Spectroscopic Studies		
	17MPH2E3D	Indepth Study - Physics of Low Dimensional Systems		
	17MPH2E3E	Indepth Study - Properties and applications of Nanomaterials		
	17MPH2R01	Project	-	15
		Total for I & II Semesters		**40**

- **No External for Indepth Study Paper**

QUESTION PATTERN FOR M.PHIL PHYSICS

Time : 3 hrs **Marks:60**

Five either or questions (one from each unit) (5x12=60)

CIA COMPONENTS FOR IN-DEPTH STUDY

Components		Marks
*Mid Semester	:	30
*End Semester	:	30
Attending Seminars (International/National) (Component I)	:	5
Paper Presentation in Seminars/Conferences (Component II)	:	15
Paper to be submitted in any International/National Research article format to the concerned guide (Component III)	:	15
Attendance (Component IV)	:	5
Total	**:**	**100**

* Mid Semester and End Semester examinations will be conducted in the I Semester and assessment in the II Semester.

RESEARCH METHODOLOGY

Semester: I **Hours: 10**

Code : 17MPH1C01 **Credits: 8**

COURSE OUTCOMES:

- Analyze the various research methodologies of science.
- Prepare the report with do's and don't's
- Compute the roots of polynomial and transcendental equations and apply interpolation techniques.
- Solve algebraic equations and analyze curve fitting using various methods.
- Solve second order differential equations and compute numerical integration using different rules.
- Apply MATLAB software to solve numerical methods and write programs with C++

UNIT I: RESEARCH METHODOLOGY

Meaning of Research - Objective of Research - Types of Research - Research Approaches - Significance of Research - Research Methods versus Methodology - Research and Scientific Method - Research Process - Criteria of Good Research - Experiments and surveys - collection of Primary data - Collection of Secondary Data - Selection of Appropriate Method for Collection - Case Study Method.

(30 Hours)

UNIT II: REPORT WRITING

Techniques of Interpretation - Precautions in Interpretation - Significance of Report Writing - Difference steps in Writing Report - Layout of the Report Writing - Types of Reports - Oral Presentation - Mechanics of Writing a Research Report - Precautions for Writing Research Report. **(30 Hours)**

UNIT III: NUMERICAL METHODS-I

Solution of Algebraic and Transcendental equations - Iteration method, Newton-Raphson method. Solution of linear Simultaneous equations - Cramer's rule, Matrix inversion method, Gauss elimination method, Gauss Jordan method, Factorization method. Curve fitting - Method of least squares. **(30 Hours)**

UNIT IV: NUMERICAL METHODS-II

Interpolation - Newton's forward and backward interpolation formula, Lagrange's interpolation formula. Numerical differentiation - Formula for derivatives, Maxima and minima. Numerical Integration - Trapezoidal rule, Simpson's rule. Solution of Ordinary Differential equations - Runge-Kutta method. **(30 Hours)**

UNIT V: NUMERICAL METHODS - MATLAB & C++

Solving small numbers of equations: Graphical method, Determinants and Cramer's rule, Elimination of unknowns - Naive Gauss Elimination - Matrix inverse - Linear least squares regression - Newton interpolating polynomial - Trapezoidal rule - Simpon's rule - Runge Kutta method. **(30 Hours)**

BOOKS FOR REFERENCE

1. Thesis and Assignment writing- J. Anderson, B.H. Durston and M. Poole, Wiley Eastern, 1977.
2. Numerical methods in Engineering & Science with Programs in C & C++ - B. S. Grewal - Eighth Reprint - Khanna Publishers, New Delhi, 2013.
3. Computer oriented Numerical Methods - V. Rajaraman - Prentice Hall, 1985.
4. Steven C. Chapra - Applied Numerical Methods with MATLAB for Engineers and Scientists, Special Indian Edition - Tata McGraw-Hill, New Delhi - Seventh reprint: 2010
5. E. Balagurusamy - Numerical Methods - Tata McGraw Hill Publishing Company Limited, New Delhi - 2005.

ADVANCED PHYSICS

Semester: I **Hours: 14**

Code : 17MPH1C02 **Credits: 12**

COURSE OUTCOMES:

- Describe different methods of preparation of thin films
- Analyze the optical and nonlinear optical properties of crystals.
- Analyze the recent developments in nanomaterials and their applications.
- Identify the properties of materials with different characterization techniques
- Describe the advancements in spectroscopic analysis

UNIT I: PREPARATION OF THIN FILMS

Thin film preparation : Physical methods - thermal evaporation -electron beam evaporation - sputtering method: Chemical bath deposition - Spray pyrolysis - ion plating - Vacuum evaporation - Evaporation theory - The construction and use of vapour sources - sputtering methods of sputtering - Reactive sputtering - RF sputtering - DC planar magnetron sputtering. **(30 Hours)**

UNIT II: CRYSTAL OPTICS AND NON-LINEAR AND ELECTRO-OPTICAL EFFECTS IN CRYSTAL

Double refraction : Optical indicatrix - Effect of crystal symmetry on optical indicatrix - Wave surface : Uniaxial and Biaxial crystals - Non-linear optics : Harmonic generation - Second Harmonic generation - Phase matching - Third Harmonic generation - Optical Mixing: Sum and difference frequencies - Parametric generation of light - Self-focusing of intense light beams - Electro-optic effects : Phase retardation - Longitudinal electro-optic modulators: Amplitude modulation - Phase modulation of light - Transverse electro-optic modulators - Electro-optic beam deflection. **(30 Hours)**

UNIT III: NANOMATERIALS AND THEIR APPLICATIONS

Properties of metallic and semiconducting Nanoparticles - various physical and chemical methods of preparation - self assembly and catalysis assisted growth methods - synthesis of Carbon nanostructures and their applications - nanostructured ferromagnetism - size and dimensionality effects in nanostructures - biological application of Nanomaterials. **(30 Hours)**

UNIT IV: CHARACTERIZATION TECHNIQUES:

Spectrophotometer - UV-VIS near IR - Basic concepts of FTIR and Raman and its applications to various materials - NMR and ESR and its applications - Thermal analysis (TG/DTA,DSC) of different materials - SEM - EDAX - TEM - Luminescence studies - VSM. **(30 Hours)**

UNIT V: SURFACE ANALYSIS TECHNIQUES

Atomic collision and Backscattering Spectrometry - Energy loss of light ions and Backscattering Depth Profiles - Sputter depth profile and Secondary Ion Mass Spectroscopy - Channeling: Basics and its application in Thin film analysis - X-ray photoelectron spectroscopy - Electron microprobe analysis of surface - Nonradioactive transitions and Angular Electron Spectroscopy. **(30 Hours)**

BOOKS FOR REFERENCE:

1. Physical properties of crystals: Their Representation by Tensors and Matrices by J.F. Nye, 1985, Oxford University Press, New York.
2. Laser and Non-Linear Optics by B.B. Laud, Chapter-13, Wiley Eastern Ltd., 1985.
3. Introduction to Nanotechnology by C.P. Pool Jr. and F.J. Owens, John Wiley & Sons.
4. Nanostructures & Nanomaterials synthesis, Properties and Applications by Guozhong Cao (World Scientific Publishing).
5. Fundamentals of surface and thin film analysis - Leonard C. Feldman and James W. Mayer.
6. A. Goswami, Thin film fundamentals, New age international (P) Ltd., New Delhi, 2006.
7. Basic principles of spectroscopy - Raymond Chang, McGraw Hill International book company.
8. Elements of X-ray Diffraction (Second Edition) BD Cullity.
9. Fundamentals of Molecular Spectroscopy by Banwell.
10. Instrumental analysis by Skoog.

THIN FILM TECHNOLOGY

Semester: I **Hours: 6**

Code : 17MPH1E3A **Credits: 5**

COURSE OUTCOMES:

- Explain the various types of vacuum formation techniques.
- Describe different methods of preparation of thin films.
- Identify the dimension of thinfilms with different characterization techniques.
- Discuss the mechanical, optical and electrical properties of thinfilms.
- List the applications of thinfilms.

UNIT I: VACUUM SCIENCE AND TECHNOLOGY

Kinetic theory of Gases: Molecular velocities - Pressure - Gas impingement on surfaces- Gas Transport and Pumping: Gas flow regimes - Conductance - Pumping speed- Vacuum Pumps: General Considerations - Rotary mechanical pump - Diffusion pump - Cryopumps - Sputter ion pumps- Vacuum systems: Components and operation - System pumping considerations - Vacuum leaks - Monitoring the vacuum environment.

UNIT II: PREPARATION OF THIN FILMS

Sputtering: DC Sputtering - RF Sputtering - Reactive sputtering - Magnetron sputtering - Plasma Etching- Physical vapor deposition: Ion plating - Reactive evaporation process - Arc plasma deposition - Ion beam assisted deposition - Ionized cluster beam deposition - Plasma immersion ion implantation- Chemical vapor deposition: Atmospheric pressure CVD - Low pressure CVD - Metal organic CVD - Laser enhanced CVD - Plasma enhanced CVD - electro plating- sol gel coating.

UNIT III: THICKNESS AND CHARACTERIZATION OF THIN FILMS

Thickness measurement : electrical methods - optical interference methods- multiple beam interferometry - Fizeau - FECO methods - Quartz crystal thickness monitor. Chemical characteristics: Auger electron spectroscopy (AES) - X ray energy dispersive analysis (EDX) - X ray photoelectron spectroscopy (XPS) - Secondary ion mass spectroscopy (SIMS).

UNIT IV: PROPERTIES OF THIN FILMS

Mechanical Properties: Adhesion- Mechanical methods - Nucleation methods - Nature of adhesion forces - Stress: Stress measuring techniques- Tensile properties: Methods of measurements - Results- Optical properties: UV Vis Spectroscopy - absorption and Transmittance. Electrical Properties: Sources of resistivity in metallic conductors - commonly measured quantities for thin films - Hall effect and Magneto resistance in thin films - Negative temperature coefficients of resistance in films- Influence of heat treatment.

UNIT V: APPLICATIONS OF THIN FILMS

Design and Fabrication of Thin film resistor - Thin film capacitor - Thin film diode - Thin film transistor - Thin film solar cells -Thin film mask blanks for VLSI - Thin films sensors for gas detectors- Magnetic sensors- storage device- magnetic thin films for MEMS and NEMS application

BOOKS FOR REFERENCE

1. Milton Ohring and Daniel Gall, Materials Science of Thin films: Deposition and Structure, Academic Press, 3rd Edition.
2. Goswami, Thin Film Fundamentals|| New Age International Ltd., 2003.
3. Krishna Seshan, Handbook of Thin - film Deposition Processes and Techniques: Principles, Methods Equipment and Applications|| William Andrew Inc., 2002
4. Donald L. Smith, Thin-film deposition: principles and practice|| McGraw-Hill Professional, 1995.
5. L.I. Maissel and R. Glang, Handbook of Thin films technology|| Mcgraw hill.

PRINCIPLES OF MATERIAL SCIENCE, SYNTHESIS AND CHARACTERIZATION

Semester: II **Hours: 6**

Code : 17MPH1E3B **Credits: 5**

COURSE OUTCOMES:

- Classify the crystal structure and analyze its defects.
- Describe the properties and applications of advanced ceramics.
- Discuss the dielectric properties of ceramic materials.
- Synthesis ceramic materials with different methodologies.
- Analyze the magnetic properties of ceramic materials.

UNIT I: STRUCTURE OF SOLIDS

Types of solid- amorphous and crystalline materials - Crystal structure (SC, BCC, FCC and HCP)-crystal defects- point defect- Defect chemical reaction-line defects

UNIT II: ADVANCED CERAMICS

Traditional and advanced ceramics- structural ceramics-electronic ceramics-ceramic processing - calcinations and sintering- Zirconium oxide-Aluminum oxide- Titanium oxide -properties and application- Cermets and application - bio ceramics and application

UNIT III: DIELECTRIC CERAMICS

Dielectric Materials- Polarization- Temperature and Frequency Effects- Electric Breakdown- Ferroelectric Materials- Dielectric Ceramics- Classification of the dielectric ceramics- Ceramic Capacitors- Dielectric Resonators

UNIT IV: CONVENTIONAL AND CHEMICAL SYNTHESIS

Mechanical mixing - ball milling- Colloidal mixing- precipitation method- Sol Gel method- Chemical vapour deposition-Physical vapour deposition- Spin coating-RF sputtering -pulsed ssLaser Method

UNIT V: MAGNETIC CERAMICS

Magnetic Materials- Terminology and Classification- Magnetic moments due to electron spin- Ferromagnetism and related phenomena- The domain structure-The Hysteresis loop- soft magnetic materials-Hard magnetic materials- Magnetic ceramics- Magnetic function and materials- Soft Ferrite

BOOKS FOR REFERENCE:

1. C.Kittel, Introduction to Solid State Physics, Wiley, New York, 1986.
2. V. Raghavan, ''Materials Science and Engineering-A First Course'', Prentice Hall of India, New Delhi, Fifth edition, 2013.
3. P.K.Palanisamy, Solid State Physics,Scitech,Chennai 2003
4. F.D.Gnanam, Ceramic Science, Volume one - 2006.
5. Yukio Sakabe, Handbook of Advanced Ceramics, Vol 1 & 2, Chapter 5.1- Dielectric Ceramics, Nurata Manufacturing Co.Ltd, Japan.
6. Takeshi Nomura, of Advanced Ceramics, Vol 1& 2, Chapter 6.1- Magnetic Ceramics, Nurata Manufacturing Co. Ltd, Japan.
7. David Brandon 'Microstructural Characterization of Materials' , John Wiley and Sons, New York, NY, 1999
8. B.D. Cullity and S.R.Stock 'Elements of X-ray Diffraction', Prentice Hall, New Jersey, 2012. Mark Ratner and Daniel Ratner, ''Nanotechnology - a gentle introduction to new idea'' Prentice Hall, 2004
9. Butterworth-Heinemann and C. R. Brunble. 'Encyclopedia of Materials Characterization', oxford press, 2002.
10. David B. Williams 'Transmission Electron Microscopy: A Textbook for Materials Science' , Plenum press, Newyork, 2003
11. Kathryn V.Logan and Zuhair A. Munir,'' Advanced Synthesis and Processing of Composites and Advanced Ceramics II'' Amer Ceramic Society, 1997

SOLAR CELL TECHNOLOGIES & SPECTROSCOPIC STUDIES

Semester: I **Hours: 6**

Code : 17MPH1E3C **Credits: 5**

COURSE OUTCOMES:

- Analyze the various types of solar cell technologies
- Enumerate the Physics theories in the emerging solar cell technologies.
- Analyze the properties of materials with UV Spectroscopy
- Explore the properties of materials with IR and Raman spectroscopy
- Apply the various measurement techniques to study the properties of materials.

UNIT I: THIN FILM SOLAR CELL TECHNOLOGIES

Generic Advantages of Thin Film Technologies - Materials - Thin Film Deposition Techniques - Common Features - Amorphous Si Solar Cell Technology - Cadmium Telluride Solar Cell Technology - Chalcopyrite (CIGS) - Thin Film Crystalline Si Solar Cell Technologies - Microcrystalline Si Thin Film Technology - Thin Film Polycrystalline Si Solar Cell - Large Grain Thin Film Crystalline Si - (Multicrystalline Si) Cells on Foreign Substrate - Thin Film Epitaxial Si Solar Cells.

UNIT II : EMERGING SOLAR CELL TECHNOLOGIES

Organic Solar Cells - Dye- Sensitized Solar Cell (DSC) - GaAs Solar Cells - Thermo-Photovoltaics (TPV) - Need to go Beyond Current Cell Technologies - Beyond Single Junction Efficiency Limit - Approaches to Overcome Single Junction Efficiency Limit .

UNIT III: ULTRAVIOLET - SPECTROSCOPY

UV and Visible spectroscopy - Transition of organic molecules - Colour and light absorption - theory of electronic spectroscopy - Bathochromic effect - Instrumentation and sampling - Choice of Solvent - Applications - Qualitative and Quantitative Analysis.

UNIT IV: IR AND RAMAN SPECTROSCOPY

Theory of IR spectroscopy - IR spectrometers - sample handling techniques - Raman spectroscopy - Sample Handling Techniques - Application of IR Spectroscopy - Raman activity - Instrumentation use of Lasers - Theory - Raman intensities and bond Polarizability - Applications to Organic, Inorganic and Physical Chemistry.

UNIT V: MEASUREMENTS

Electrical conductivity and resistivity measurements - two probes four probes and Vander Pauw methods - Dielectric constant measurements - surface studies etching - scanning electron microscope - Particle induced X-ray emission (PIXE) - Rutherford Back scattering.

BOOKS FOR REFERENCE:

1. Solar Photovoltaics Fundamentals, Technologies and Applications - Chetan Singh Solanki PHI Learning Private Ltd- Third Edition.
2. Organic Spectroscopy - William Kemp,1991 Palgrave edition
3. Spectroscopic Identification of Organic Compounds - Silverstein Bassler and Morrill - John -Wiley
4. Material Science and Metallurgy - O.P.Khanna.

PHYSICS OF LOW DIMENSIONAL SYSTEMS

Semester: I **Hours: 6**

Code : 17MPH1E3D **Credits: 5**

COURSE OUTCOMES:

- Distinguish the band structure in various dimensions
- Explain the growth and properties of hetero structures
- Describe the dynamics of the particles in low dimensional systems
- Interpret the behavior of impurities and external perturbations in heterostructures
- Formulate programs using Mathematica software

UNIT I: ELECTRONS AND PHONONS IN CRYSTALS

Band structure in one dimension - Motion of electrons in bands - Density of states - Band structure in two and three dimensions - Crystal and band structure of the common semiconductors - Optical measurement of the band gaps - Phonons.

UNIT II: HETEROSTRUCTURES

General properties of heterostructures - Growth of heterostructures - Band engineering - Layered structures: quantum wells and barriers - Doped heterostructures - Strained layers - Silicon-Germanium heterostructures - Wires and dots - Optical confinement - Effective-mass approximation - Effective-mass theory in heterostructures.

UNIT III: LOW DIMENSIONAL SYSTEMS

Infinitely deep square well - Square well of finite depth - Parabolic well - Triangular well - Low dimensional systems - Occupation of Sub-bands - Two and three dimensional potential wells - Further confinement beyond two dimensions - Quantum wells in heterostructures.

UNIT IV: IMPURTIES, EXCITONS AND APPROXIMATION METHODS

Donors and acceptors in bulk material - Binding energy in a heterostructures - Two and three dimensional trial wave functions - Effective mass and dielectric mismatch - Band non-parabolicity - Excited states. Excitons - Excitons in two and three dimensions - Excitons in a quantum well - Quantum confined Stark effect - Excitons, fluctuations and Phonons.

UNIT V: MATHEMATICA

Structure of Mathematica - Interactive use of Mathematica - Symbolic calculations - Numerical calculations - Graphics - Programming. Quantum Mechanics: The Schrödinger equation - One dimensional potential - The harmonic oscillator. Packages and Programs: Quantum well - Harmonic oscillator - Anharmonic oscillator.

BOOKS FOR STUDY

1. The Physics of Low-Dimensional Semiconductors - An Introduction - John H. Davies - Cambridge University Press (New York), 1998.
2. Quantum Well, Wires and Dots - Paul Harrison - 3rd Edition - A John Wiley and Sons Ltd, England, 2010.
3. Mathematica for Theoretical Physics - Classical Mechanics and Nonlinear Dynamics - Gerd Baumann - 2nd Edition - Springer Verlag, USA, 1993.
4. Mathematica for Theoretical Physics - Electrodynamics, Quantum Mechanics, General Relativity and Fractuals - Gerd Baumann - 2nd Edition - Springer Verlag, USA, 1993.

BOOKS FOR REFERENCE

1. Physics of Semiconductors - B. Sapoval and C. Hermann- Springer (India) Private Limited New Delhi, 2010.
2. Introduction to Nanotechnology - Charles P. Poole and Frank J. Owens - Wiley India (P) Ltd, New Delhi, 2006.
3. Programming with Mathematica - An Introduction - Paul Wellin - Cambridge University Press, New York, 2013.

PROPERTIES AND APPLICATIONS OF NANOMATERIALS

Semester: I **Hours: 6**

Code : 17MPH1E3E **Credits: 5**

COURSE OUTCOMES:

- Explain the types and importance of nanomaterials
- Discuss the physics of nanomaterials and explain their properties
- Describe the various synthesis methods of nanomaterials
- Explain synthesis and applications of carbon nanotubes
- Identify the various applications of nanomaterials

UNIT I: NANOMATERIALS

Importance of nanoscale- Moore's law- applications- Risk of Nanomaterials- Carbon based materials - Fullerenes - Carbon Nano Tubes - Nanobuds- Inorganic Nanotubes- Nanoshells - Quantum Well - Quantum Wires - Quantum Dots- Dendrimers - Biological Nanomaterials- Diamondoids - Smart Nanomaterials.

UNIT II: PROPERTIES OF NANOMATERIALS

Size dependence of properties - properties of Nanomaterials - chemical reactivity - solubility - Melting points- Electronic Energy Levels- Electrical Conductivity- Superparamagnetism- Electron Confinement- Integrated Optics- Optical Properties- Mechanical Properties- Thermodynamic Properties- Scaling laws - Device Performance

UNIT III: SYNTHESIS OF NANOMATERIALS

Lithography - Epitaxy - Sputtering - Chemical Vapor deposition - Sol-Gel Technology - Nanotube synthesis

UNIT IV: CARBON NANOSTRUCTURES

Introduction - Allotropes of Carbon - Fullerene C_{60}- Carbon Nanotube Structures- Applications of carbon Nano Tubes.

UNIT V: APPLICATIONS OF NANOMATERIALS

Introduction- Molecular and Nanoelectronics- Self Powered Nanosystems- Microbial Fuel Cells- Adenosine Tri-Phosphate (ATP) Energy Converter - Thermo electric Generator- Piezoelectric Nanogenerator - Fiber based Nanogenerator - Solar Photovoltaic cells- Hydrogen Storage- Nanomedicine- Biological Applications- Catalysis- Pollution Control and Filtration - Photonic Nanocrystals and Integrated Circuits- Nanomaterials in Communication Sector.

BOOK FOR STUDY:

Nanotechnology- An Introduction to synthesis, properties and Applications of Nanomaterials, Thomas Varghese, K.M. Balakrishna, Atlantic Publishers and distributers (P) Ltd. 2012.

BOOKS FOR REFERENCE:

1. B. Bhusion, Hand book of Nanotechnology, Springer- Heidelberg, 2004
2. C.N.R. Rao, A. Muller, A.K.Cheetham, The Chemistry of Nanomaterials: Synthesis, Properties and and Applications, Springer, 2002.
3. M. Meyyappan, Nanotechnology: Opportunities and Challenges, NASA Ames Research Centre (www. Ipt.arc.nasa.gov)

PROJECT

Semester: I **Credits: 15**

Code : 17MPH2R01

COURSE OUTCOMES:

- Survey the literature related to their specified field
- Choose the methodology
- Prepare the flowchart of their work
- Execute the work in a proper way and interpret their findings
- Prepare the report, present and publish their findings.