ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM
DEPARTMENT OF PHYSICS

M. Phil PROGRAMME IN PHYSICS

UnderCredit & Semester System

(2016 admissions onwards)

Programme Overview

1. **The Master of Philosophy (M.Phil)** in Physics is a semester based one year programme designed for academicians and researchers to provide theoretical and practical research exposure in Physics. The programme empowers the researchers with domain specific capabilities and methodological competencies.

2. **Course Duration**

   The duration of the course is one year spread across two semesters.

3. **Eligibility criteria**

   Pass in M.Sc Physics (Pure, Applied, Materials Science, Theoretical Physics, New & Renewable energy, Non-conventional Energy Physics)with not less than 55% marks.The degree shall be recognized by M G University. The SC/ST candidates are given 5% relaxation for the prescribed minimum marks.

4. **Admission procedure**

   Admission will be on the basis of the marks in the qualifying examination, written test and/orinterview. Direct entry for the programme may be allowedto CSIR- JRF / NET/ GATE qualified candidates and permanent college teachers with five years of experience.

Curriculum and Syllabus

Course Structure

Course code	Semester	Course title	Teaching hours per week	Credit	Exam Duration	Total Marks	
						IA	EA
PH1C1MP	I	Research Methodology	8	5	3 hrs	25	75
PH1C2MP	I	General Physics	8	5	3 hrs	25	75
PH1E*MP	I	Elective Course	9	6	3 hrs	25	75
PH2PRMP	II	Project	25	16	30 minutes	50	150
PH2PVMP	II	Viva on Project	0	4		25	75
			Total Credit	36		150	450

Electives (One Elective to be selected)

Course code	Course title
PH1EAMP	Non Linear Dynamics
PH1EBMP	Thin Film Technology
PH1ECMP	Nano Materials and Nano Photonics

Course Code

The first two letters of the code indicates the name of discipline i.e., PH stands for Physics. Next digit is to indicate the semester. i.e., PH1 (Physics, 1st semester) followed by the letter C or E indicating whether the course is core course or elective course as the case may be. Next digit indicates course number. The letters PR/ PV are used to indicate project/ viva on project. The last letter will be MP which indicates that the programme is M. Phil.

The elective courses are coded in similar pattern except the letter C denoting the core course is replaced by letter E for elective and the letter A/ B/ C indicates the Elective chosen.

Thus PH1C1MP represents Physics 1st semester core course 1 for M Phil programme and PH1EAMP represents Physics 1stsemester Elective course "A" for M Phil Programme.

GRADING AND EVALUATION

Examinations

The evaluation of each course shall contain two parts such as SessionalAssessment andFinal Assessment. The ratio betweenSessional and Final Assessmentsshall be 1:3 as per University guidelines.

Sessional Assessment

Sessional assessment is to be done by continuous assessments with the following components. Two tests will be conducted for Sessional Assessment for each course. Average of the two marks will be taken. The components of the Sessional Assessmentfor theory, project and their marks are as given in the Tables. The test paper should be of the same model as that of theFinal Assessment, the model of which is discussed below. The duration and the number of questions in the paper may be adjusted judiciously by the college for the sake of convenience.

Theory (Semester I)	
Component	Marks
Attendance	5
Assignments/Viva	5
Seminar	5
Test	10
Total	25

Project	Marks
Relevance /Quality of project under study	10
Literature survey	10
Experimental/Theoretical / Data validation/ Modelling	10
Result and Dissertation layout	10
Presentation of the project	10
Total	50

Distribution of weights and components of theory and project

Attendance		Assignments		Seminar	
% of Attendance	Mark	Components	Marks	Components	Marks
≥90%	5	Punctuality	1	Innovation of Topic	1
<90 and ≥85%	4	Content	2	Content	1
< 85%and≥80%	3	Conclusion	1	Presentation	2
<80%and≥75%	2	References	1	Conclusion	1
		Total	5	Total	5

Final Assessment

Final Assessment will be external assessment. Question papers for the Final Assessment will be set by external examiners. Both project evaluation and viva voce are to be conducted in batches of maximum number of 6 students each.

Question Paper Pattern for Theory Courses.

All the theory question papers are of three hour duration and have two parts.

Part A: (Short essay/ problem) Nine questions have to be answered from among twelve questions. Each question will carry five marks and the Part A will have total marks of 45.A minimum of twoquestions must be asked from each unit of the course.

Part B: (Essay/Long answer questions) Part B will have two questions of equal standard**.** Each question must be answered from among the two options given. One question of equal standard must be asked from each unit. Each question carries 15 marks. Thus Part B will comprise a total of 30 marks.

Reappearance: For reappearance as per the rules of the institution, students can appear along with the next regular batch of students of the particular semester. A maximum of two chances will be given for each failed paper. Only those Papers in which candidate have failed need to be repeated.

Project Evaluation (End Semester Assessment): Candidate shall submit the dissertation not earlier than 5 months but within 6 months from the date of start of second semester. A candidate who fails to submit the dissertation within 6 months she shall be given an extension time of 4 months in the first instance and another 4 months in the second instance. After two extension her registration shall be treated as cancelled and she has to re register for the programme. The candidate need not write the theory papers again, if she has already passed these courses.

The project is evaluated by one external and one internal examiner deputed from the board ofexaminers. The dissertation of the project is examined along with the oral presentation of the project by the candidate. The examiners should ascertain that the project and report are genuine. Innovative projects or the results/findings of the project presented in national seminars may be given maximum advantage.

COMPUTATION OF CCPA

Grade and Grade Point is given to each course based on the percentage of marks obtained as follows:

Percentage of Marks	**Grade**	**Grade Point**
90 and above	A+ - Outstanding	10
80-89	A - Excellent	9
70-79	B - Very Good	8
60-69	C - Good	7
50-59	D - Satisfactory	6
Below 50	E- Failure	--

Note: Decimal are to be rounded to the next whole number

CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula ***CP = C* x *GP,***

*Where**C** = Credit for the course; **GP** = Grade point*

Semester Credit Point Average (SCPA) is calculated as**SCPA**= $\frac{\boldsymbol{Total\ Credit\ Points\ (TCP)}}{\boldsymbol{Total\ Credits(TC)}}$

Grades for the different semesters / programme are given based on the corresponding SCPA on a 5-point scale as shown below:

SCPA	**Grade**
9 and above 9	A+ - Outstanding
8 and above but below 9	A – Excellent
7 and above but below 8	B -Very Good
6and above but below 7	C – Good
5 and above but below 6	D – Satisfactory
Below 5	E-Failure

Cumulative Credit Point Average for the programme is calculated as follows:

$$\textbf{CCPA} = \frac{(TCP)_1 + \ldots\ldots\ldots + (TCP)_4}{TC_1 + \ldots + TC_4}$$

where **TCP_1……..,** **TCP_4**are the **Total Credit Points** in each semester and **TC_1……..,** **TC_4**are the **Total Credits** in each semester

Note:A separate minimum of **50% marks** each for In andEnd Semesters is required for pass for a course. For a pass in a programme, a separate minimum of Grade D is required for all the individual courses. If a candidate secures **E**Grade for any one of the courses offered in a Semester/Programme only **E** grade will be awarded for that Semester/Programme until he/she improves this to **D** grade or above within the permitted period.

SYLLABI OF COURSES

CORE COURSES

Core Course -I

PH1C1MP: Research Methodology

Course Overview: The course on research methodology is designed to assist students in planning and carrying out research projects. The students are exposed to the principles, procedures and techniques of academic research. The course starts with an introduction to research and continues with the significance of literature survey and the various sources available. The tools used for data analysis and the computational tools are then discussed. It includes the statistical techniques for data analysis and the basic principles of programming and of implementing mathematical concepts using MATLAB and Python.

Unit I - Research Methodology

Meaning of research – Objectives and Motivation of Research – Types of research – Selection and formulation of Research Problem. Research Design – Need – Features – Inductive, Deductive and Development of models - Developing a Research Plan – Exploration, Description, Diagnosis, Experimentation,

Research literature survey - Primary, secondary and tertiary sources- Information search using digital library and internet – Ideas of theoretical, experimental and computational research methods.

Unit II - Research Communications

Research communications-different categories and formats-paper preparation for scientific journals -word processing and publication software- LATEX documents- Preparation of a research paper

Writing scientific report, structure and components of research report, revision, writing project proposal, writing a Research Paper, Citation counting and Impact factor, Science citation index (SCI)/ Science citation index Expended (SCI-E), H-index, Academic Ethics and Plagiarism, Intellectual Property Rights and Patent law.

Unit III - Data analysis

Error analysis, statistical data analysis on data in physics context - coding, editing, tabulation of data descriptive statistics- various kind of charts and diagrams used in data analysis, applications of statistical techniques for analyzing the data, uses of data analysis tools - SPSS,

ORIGIN- Testing of significance, mean, proportion, variance and correlation - testing for difference between mean, proportion, variance and correlation coefficients.

Unit IV – Computational Tools

MATLAB – Arithmetic operations – elementary MATH built –in functions – Arrays – creation, addressing and mathematical operations – script files – two dimensional plots – Programming in MATLAB – Polynomials, curve fitting and interpolation

Python Programming - Introduction. Python Overview. Basic data types and variables, operators, conditional statements – if, if – else, nested if –else. Looping – for, while and nested loops. Control statements, string manipulation, Tuples, Lists, Dictionaries, Functions, Modules, Input – output, Exceptions.

References

1. An introduction to Research Methodology, Garg.B.L., Karadia, R., Agarwal,F. and Agarwal, U.K.,(RBSA Publishers. 2002)
2. Research Methodology, Sinha, S.C. and Dhiman, A.K. EssEss Publ,2volumes
3. Research Methodology: Methods and Techniques, C.R.Kothari, (New age international, New 2006)
4. Writing Your Thesis, P. Oliver, New Delhi: Vistaar Publications, 2004.
5. Ethics in Research, Gregory,Continuum, 2005.
6. Thesis and Assignment writing J.Anderson, B.H.Durston and M.Poole, (Wiley Eastern, New Delhi 1977)
7. Hand Book of Methodology of Research, RajammalDevadas, (RMM. Vidyalaya press 1976)
8. The LATEX Companion, F. Mittelbach and M. Goossens, 2nd. ed. (Addison Wesley, 2004)
9. Research methodology and statistical Measurement, Reddy and Rao
10. An introduction to error analysis, - the study of uncertainties of physical measurements. Taylor, John R. , University Science Books, 1982.
11. Mathematical Physics, H.K.Dass, S.Chand& Company, New Delhi, 2003
12. MATLAB, A Gilat, John Wiley & Sons (2004)
13. Getting Started with MATLAB 7: A Quick Introduction for Scientists and Engineers, RudraPratap, Oxford University Press.
14. The Fundamentals of Python: First Programs, Kenneth A. Lambert, , 2011,

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

M. Phil Programme in Physics - SEMESTER I

PH1C1MP: Research Methodology

Model Question Paper

Time: 3 Hours **Maximum Marks: 75**

Part A

(Answer any nine questions. Each question carries 5 marks)

1. What are the steps involved in the process of selection and formulation of a research problem?
2. Discuss the need for a research design.
3. Compare Deductive and Inductive methods of research
4. What are the advantages of using LATEX for preparing scientific documents?.
5. Write a note on Intellectual Property Rights.
6. Discuss how a reviewer can avoid plagiarism.
7. What is the role of SPSS in data analysis?
8. What is analysis of variance? Give an example to illustrate the same.
9. Ten students got the following percentage of marks in the course principles of Economics and Statistics.

Roll No	1	2	3	4	5	6	7	8	9	10
Marks in Economics	78	36	98	25	75	82	90	62	65	39
Marks in Statistics	84	51	91	60	68	62	86	58	53	47

Calculate the coefficient of Correlation.

10. Write a Matlab code to calculate the following summation:

3*(2+1) + 4*(3+2+1) +5* (4+3+2+1) + 6* (5 + 4 + ….1) + …..+1000 * (999 +998 + ….+1)

Using nested for loops.

11. Write a program using Python to sum the number of integers from 1 to a given number n.

12. Discuss briefly about tuples in python.

(9 x 5 = 45)

Part B

(Answer all questions. Each question carries 15 marks)

13. Differentiate between primary, secondary and tertiary sources. Discuss the advantages and disadvantages of web sources.

Or

Describe, in detail the layout of a research report. Discuss the difference between a technical report and a popular report.

14. Discuss statistical data analysis with special emphasis on data in physics context. ? What precautions should be taken while interpreting the data?

Or

Using examples, explain how to generate C^{++} codes in MATLAB platform.

Assume that you have a set of data representing an absorption spectrum. Write a program to fit the data using Gaussian broadening condition and find out the full width at 1/e maximum of the peak.

(2 x 15 = 30)

Core course-II

PH1C2MP: General Physics

Course Overview: The course in General Physics is designed to give a strong foundation in theoretical as well as Experimental Techniques of Research in Physics. The first two units are dealing with advanced quantum mechanics and Group Theory. Third unit details the basic principles and applications of various characterization techniques specifically structural, morphological and optical characterization techniques. The next unit convey an introduction to nanoscience including fundamentals of nanomaterials, its classification and synthesis.

Unit 1 Advanced Quantum Mechanics

Quantization of fields

Quantisation rules for Bose and Fermi particles, Quantisation of relativistic fields- K G Field, Dirac field, Electromagnetic fields using Lorentz gauge, Interacting fields, Dyson

chronological products, the scattering Matrix, Wicks chronological products, Normal products, Feynman Diagrams.

Symmetries in quantum Mechanics

Discrete symmetry transformations- Parity, Charge conjugation, Time reversal, TCP theorem.

References

1. Field quantization-Walter Greiner, Joachim Reinhardt, Springer 2009
2. Introduction to quantum field theory- S J Chang, World Scientific 1990
3. Quantum Mechanics V K Thankappan, Weily Eastern limited
4. Quantum field theory- F Mandl and E Shaw, John Wiley & sons 1990
5. Quantum field theory - L Ryder, Academic Publishers, Culcutta 1989
6. Quantum Mechanics B H Bradsen and C J Joachain Pearson Education.
7. Quantum Mechanics L I Schiff McGraw hill

Unit II : Mathematical Physics

Group Theory

Group Theory: Definition, review of groups: Irreducible representations of groups, discrete and continuous groups, Lie groups, Lie algebra, how symmetries form a group, unitary and anti-unitary symmetry operators,angularmomentumalgebra, Rotationional transformations and O(3) group,Representation of rotation through Eulerian angles, Homomorphism with Unitary group, representation of rotation by representation of Unitary group, representation matrices, Wigner coefficients, Tensor operators,Wigner-Eckart theorem, Rotation inversion group, Discrete Symmetries- Space and Time reversal symmetries.

References

1. M. Tinkham, Group Theory and Quantum Mechanics, Tata- McGraw Hill
2. L. I. Schiff, Quantum Mechanics, McGraw-Hill Book Co. (1968)..
3. L. H. Ryder, Quantum Field Theory, Cambridge University Press
3. Mathematical Methods for Physicists, B Arfken and H J Weber, Academic press
4. Elements of Group theory for Physicists, A W Joshi New Age India Pub 1997
5. Chemical Applications of group theory, Albert Cotton
6. Mathematical Physics SatyaPrakash Sultan Chand & Sons,
7. Symmetry and Spectroscopy of Molecules, KVeera Reddy, New Age International (P) Ltd
8. Symmetry in Physics, Vol 1 J P Elliot and P G DewberMcMillian

Unit III:Characterization Techniques

X-ray diffraction- basic principles, applications- structure, size, lattice strain analysis. Scanning electron and Transmission Electron Microscopy, Field Emission Microscopy, Scanning Tunnelling Microscopy and Atomic Force Microscopy- Basic principles. Optical characterization- UV Visible spectroscopy (absorption and emission)-FT IR- Raman spectroscopy- Basic principles and applications.

References:

1. Characterization of Materials John B. Watchman
(Butlerworth - Heinemann Manning Greenwich)
2. Quantitative Analysis - Day Underwood.
3. Fundamentals of Analytical Chemistry Skoog, West Holler.
4. Modern Methods for trace element determination,C. Vandecasteele, (C. B. block - John Wiley and sons (NY).)

Unit IV :Nanoscience

Nanomaterials- fundamentals- structure, classification based on dimension- quantum dot, quantum wire, quantum well, surface to volume ratio.Nanoclusters-magic numbers-basics of quantum confinement.

Synthesis of nanostructures- top down and bottom up approach. Introduction to Carbon nanostructures- CNT and Graphene.

References:

1) Nanomaterials, Nanotechnologies and Design, Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby, Elsevier.
2) Nanotechnology Applications to Telecommunications and networking, Daniel Minoli, Wiley 2006.
3) Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Guozhong Cao, Ying Wang, World Scientific

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

M. Phil Programme in Physics - SEMESTER I

PH1C2MP :General Physics

Model Question Paper

Time: 3 Hours **Maximum Marks: 75**

Part A

(Answer any nine questions. Each question carries 5 marks)

1. How does the quantization rules for Bose particles differs from that of Fermions?
2. Discuss the Scattering Matrix with respect to quantum field theory.
3. Illustrate the graphical translational rules for Feynman diagrams.
4. Illustrate Wigner Eckart theorem.
5. What are Lie groups? Illustrate with example.
6. Illustrate the relation between rotational transformations and O(3) group.
7. With neat diagram explain the principle of SEM.
8. Briefly explain different applications of Raman Spectroscopy.
9. Explain the structural determination using XRD technique.
10. Illustrate the quantum confinement effect.
11. Write a brief note on carbon nano tubes.
12. Write on the classification of nanomaterials based on dimension.

(9 x 5 = 45)

Part B

(Answer all questions. Each question carries 15 marks)

13. a. Illustrate the quantisation of Electromagnetic field in Lorentz gauge.

OR

b. What are Unitary groups? Discuss representation of rotation by representation of Unitary group.

14. a. Describe the basic principles and applications of UV Visible spectrosco2y.

OR

b. Write on the different approaches for the synthesis of nanomaterials.

(2 x 15 = 30)

ELECTIVE COURSES

Elective-1

PH1EAMP:NONLINEAR DYNAMICS

Course Overview: This course provides a broad introduction to the field of nonlinear dynamics. The properties of linear and nonlinear systems are reviewed.Damped and driven linear and nonlinear oscillators are studied. The dynamics of maps associated with discrete-time systems are studied unpacking the notions of state space, trajectories, attractors and basins of attraction, stability and instability and bifurcations. The methods of controlling chaos are discussed. Chaotic phenomenon is the discussed in detail using classical and quantum theories.

Unit I – Nonlinear Dynamics

Linear and Nonlinear systems – Mathematical models examples – Mathematical Implications of Nonlinearity: superposition principle – Linear oscillators & Predictability – Damped and Driven Nonlinear oscillators.

Autonomous and Non autonomous systems – Phase plane trajectories – stability, attractors &repellers - equilibrium points and stability – limit cycle motion – Poincare – Benedixson theorem – Higher dimensional systems.

Unit II - Onset and Control of Chaos

Bifurcations - saddle node, pitch fork, transcritical and Hopf. Discrete dynamical systems – Logistic map - General characteristics of chaotic systems. Route of transition to chaos (intermittency, quasi-periodicity, period-doubling). Chaotic states characterization (Lyapunov exponents, Kolmogorov-Sinai entropy, correlation dimension, capacity dimension, fractal dimensions). Chaotic systems examples. Controlling of chaos and controlling algorithms a brief outline.

Unit III – Chaos in conservative Systems

Dissipative and conservative systems; Poincare cross section, possible orbits in conservative systems, regular and irregular trajectories, Canonical perturbation theory, Henon-Heiles system, periodically driven undamped Duffing oscillator, the standard map, KAM theorem.

Unit IV - Quantum Chaos

The energy level spectra of chaotic, bounded, time independent systems – wave functions for classically chaotic, bounded and time independent systems - temporally periodic systems – quantum chaotic scattering.

References:

- M. Lakshmanan and S. Rajasekar, Nonlinear dynamics, Integrability, chaos and patterns, Springer – Verlag(2003)
- E. Ott, Chaos in Dynamical Systems, Cambridge University Press (1992).
- M.Lakshmanan and K.Murali, Chaos in Nonlinear Oscillators, World Scientific, Singapore, 1989.
- S.Strogatz, Nonlinear Dynamics and Chaos, Addison Wesley, 1995
- A.J. Lichtenberg and M.A. Lieberman, Regular and ChaoticDynamics, Springer-Verlag (1992).
- V.I. Arnold, Mathematical Methods of Classical Mechanics, Springer-Verlag (1979)
- M.Tabor, Chaos and Integrability in Nonlinear dynamics (John Wiley, 1989)
- Quantum Chaos: An Introduction, Hans-JuergenStoeckmann, Cambridge University Press (1999)
- Quantum Signatures of Chaos, Fritz Haake, Springer Verlag, 3rd edition (2010)
- Chaos: Classical and Quantum, P. Cvitanovic, R. Artuso, R. Mainieri, G. Tanner and G. Vattay, ChaosBook.org, Niels Bohr Institute, Copenhagen (2010) [a webbook about classical and quantum chaos]

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

M. Phil Programme in Physics - SEMESTER I

PH1EAMP :NONLINEAR DYNAMICS

MODEL QUESTION PAPER

Time: 3 Hours **MaximumMarks: 75**

PART A

(Answer any nine questions. Each question carries 5 marks)

1. Write a note on linear and nonlinear systems.
2. Discuss different types of attractors and repellers in phase space.
3. Distinguish between correlation dimension and capacity dimension.
4. What are saddle node bifurcations?
5. Briefly discuss logistic map.
6. Write an analysis of dissipative and conservative systems.
7. Write a short note on Henon-Heiles system.
8. Briefly discuss quantum chaotic scattering.
9. Discuss two higher dimensional chaotic systems.
10. Write a note on KAM theorem.
11. State and explain Poincare-Benedixson theorem.
12. Discuss the importance of Komolgorov – Sinai entropy.

(9×5=45)

PART B

(Answer all questions. Each question carries 15 marks)

13. a. Discuss linear and nonlinear oscillators. Also discuss the different characteristics of a chaotic system.

OR

b.Discuss the possible orbits in a conservative system.

14. a. Discuss different methods of controlling chaos.

OR

b. What is meant by quantum chaos? Discuss energy level spectra of chaotic, bounded and time independent systems.

(2×15=30)

Elective-2

PH1EBMP: THIN FILM TECHNOLOGY

Course overview:

This course on thin films gives insight about the preparation of thin films by various techniques and its various properties and applications. The first unit is about various preparation methods. The second module focuses on the various thickness measurement techniques and theories of nucleation for thin film growth. Third module is about electric properties of thin films. Fourth module emphasizes on the optical properties and the importance of thin films in solar cell and various advancements in solar cell technology.

Unit I

Physical and Chemical methods for preparation of thin films

An introduction to thin films - Physical methods– Evaporation theory and mechanism - Rate of evaporation – Hertz-Knudson equation –Vacuum evaporation–Methods of evaporation-resistive heating-flash evaporation –laser evaporation.Sputtering- DC sputtering – Ion beam sputtering – RF sputtering – Spin coating techniques.

Chemical methods – CVD- reaction chemistry and thermodynamics of CVD-Spray pyrolytic process – Mechanism and characteristic features of spray pyrolytic process – electrodeposition– anodization – thermal growth- Growth of epitaxial films- Basic ideas of molecular beam epitaxy-Langmuir–Blodgett film.

.**Unit II**

Thickness measurement and nucleation growth in thin films

Thickness measurement - Optical methods – Multiple beam interferometry- FECO-Fizeau's technique – Ellipsometry – Vamfo – other techniques – Quartz crystal thickness monitor.Theories of thin film nucleation – capillarity – atomistic – stages of film growth – incorporation of defects during growth

Unit III

Electrical properties of metallic thin films

Electrical properties of metallic films- sources of resistivity – sheet resistance – temperature coefficient of resistance (TCR) -electrical conduction of thin insulating films-possible conduction mechanisms-general considerations- influence of thickness on resistivity - Hall effect and magnetoresistance.

Dielectric analysis- properties and losses- Ohmic contact-metal-insulator and metal metal contacts- AC and DC conduction mechanism.

Unit IV

Optical properties of thin films and thin film solar cells

Reflection and transmission of single layer film – normal incidence case – refractive index measurement techniques – reflectivity - variation with thickness. Application of optical films -anti-reflecting coatings. Thin film solar cells: Solar Energy Conversion-Efficient Conversion - Materials Requirements for Efficient Conversion- role, progress and production of thin solar cells –Photovoltaic measurements- I-V Characteristics, Spectral response. First, second, third generation solar cells- organic based solar cells,Dye sensitized solar cell, Quantum dot solar cells, Pervoskite based solar cells.

References

- K. L. Chopra, Thin film phenomena-Robert E Kriga publishing Co. NY(1929)
- Meissel and Glang, Handbook of thin film technology, McGraw Hill(1970)
- Dupy and Cachard, Physics of non-metallic thin films: plenum press(1976)
- A Goswami, Thin film fundamentals, New Age International Pvt.Ltd(1996)
- LudmilaEckertova, Physics of thin films, Springer science and business media(2012)
- Joy George, Preparation of thin films, Marcel Decker NY(1992)
- John L. Vossen, Werner Kern,Thin Film Processes II, Gulf Professional Publishing(1991)
- Robert W. Berry, Peter M. Hall, Murray T. Harris, Thin film technology,Van Nostrand Reinhold Co. NY(1968)
- D. R Lamp, Electrical conduction mechanisms in thin insulating films, Mathew and Co(1967)

- K. L Chopra, S. R Das, Thin film solar cells, Springer science and business media(2013)
- Tetsuo Soga, Nanostructured materials for solar energy conversion (Ist edition),Elsevier (2006)
- Hartmut Frey, Hamid R Khan, Handbook of thin film technology, Springer science and business media(2015)

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

M. Phil Programme in Physics - SEMESTER I

PH1EBMP: THIN FILM TECHNOLOGY

MODEL QUESTION PAPER

Time: 3 Hours **Maximum marks: 75**

PART A

(Answer any nine questions. Each question carries 5 marks)

1. Write a note on Vacuum evaporation.
2. Briefly discuss about molecular beam epitaxy.
3. Give a short note on RF sputtering.
4. Explain the quartz crystal method for thickness measurement.
5. Write a short note on incorporation of defects during growth.
6. Give an account on sheet resistance.
7. Explain the influence of thickness on resistivity.
8. What do you mean by Hall effect?
9. What is magnetoresistance?
10. What is the role of thin film in solar cells?
11. What is meant by efficient conversion in solar cells and what are the material requirements for it?
12. Write a short note on Dye sensitized solar cells.

(9×5=45)

PART B

(Answer all questions. Each question carries 15 marks)

13. a. Write a note on any two chemical methods for the synthesis of thin films.

OR

b. Give the capillarity theory of thin film nucleation.

14. a. Give the possible conduction mechanisms in thin insulating films.

OR

b. Give the theory of reflectance and transmittance of thin films and obtain the curve for variation of reflectance with optical thickness.

(2×15=30)

Elective-3

PH1ECMP:Nanomaterials and Nanophotonics

Course overview:

This paper is designed in such a way as to give an in depth knowledge of nanoscience and nanophotonics. The first unit gives a fundamental understanding of nanomaterials, various confinement effects and physical and optical properties that are modified due to these confinement effects. Unit II is about various synthesis and characterization methods. Unit III describes various applications of nanmateials and the last unit is a detailed analysis of nanophotonics.

Unit I

Introduction and Properties of Nanomaterials

Nanomaterials-Review of fundamental properties of nanomaterials, surface curvature, strain confinement, Classification based on dimension- 0D, 1D and 2D nanostructures, Exciton, Quantum confinement effects: - Strong and weak confinement, Density of States in low dimension, Properties of Nanostructures: Mechanical properties, Thermal properties, Electrical properties, Magnetic properties, Optical properties, acoustic properties.

Unit II

Synthesis and Characterization Technologies of Nanomaterials

Synthesis of nanostructures –Top down and bottom up approaches, Preparation techniques of zero, one and two dimensional nanostructures, Inert gas condensation, coprecipitation, self assembly, hydrothermal, template assisted method, CVD, PLD, thermal evaporation, ball milling, Lithography- photolithography, electron beam lithography.

Characterization- XRD, FTRaman and FTIR, TEM and SEM, STM and AFM, UV-Vis spectroscopy.

Unit III

Nanomaterials and Applications

Fullerene- structure, crystal structure, properties and applications, CNT- fabrication, structure, classification, properties and applications, Graphene- structure, properties and applications, hybrid structures, Nanocomposites, Core-shell structures.

Applications of Nanostructures: Biological application- Biomedicine, drug delivery, Energy applications- Photoelectrochemical cells, Lithium storage rechargeable batteries, Hydrogen storage, GMR and CMR, Nanocatalysis.

Unit IV

Nanophotonics

Foundations for nanophotonics: Comparison of electrons and photons. Photonic crystals: basic properties, 1D, 2D and 3D photonic crystals. Designing photonic crystals for mirrors, waveguides, cavity, filter, waveguide bend, waveguide splitter, reflection, refraction and diffraction. Photonic crystal fibers. Plasmonics: the basics, near field interaction and near field microscopy exploiting surface plasmons, waveguiding with surface plasmonpolaritons, amplification and lasing with surface Plasmon polaritons, surface enhanced raman spectroscopy.

Nano-plasmonics for bio-photonics: An introduction, photons and photon correlation spectroscopy, principles and applications of fluorescence correlation spectroscopy, nanoscopy using localization and temporal separation of fluorescence from single molecules.

References:

1) Nanomaterials, Nanotechnologies and Design, Daniel L. Schodek, Paulo Ferreira, Michael F. Ashby, Elsivier
2) Nanostructures and Nanomaterials: Synthesis, Properties, and Applications, Guozhong Cao, Ying Wang, World Scientific
3) Synthesis, properties and applications of oxide nanomaterials, Jose A. Rodriguez, Marcos Fernandez-Garcia, Wiley.
4) Nanotechnology: Fundamentals and Applications,ManasiKarkare, IK International Publishers.
5) Nanophotonics, Paras N Prasad
6) Photonic crystals:Moulding the flow of light, John D Joannopoulos, Princeston University Press, 2008
7) Biophotonics: Spectroscopy, Imaging, Sensing, and Manipulation, Editors: Bartolo, Baldassare Di, Collins, John; Springer
8) Nanoparticle Technology Handbook, Masuo Hosokawa, Kiyoshi Nogi, Makio Naito, Toyokazu Yokoyama Elsevier 2007.
9) A Textbook of Nanoscience and Nanotechnology, T. Pradeep, Tata McGraw Hill
10) Nanophotonics: Devices, circuits and systems, PreechaYupapin, PanStansford Publishing
11) Introduction to Nanophotonics, Sergey V. Gaponenko, Cambidge University Press

ST. TERESA'S COLLEGE (AUTONOMOUS), ERNAKULAM

M. Phil Programme in Physics - SEMESTER I

PH1ECMP: NANOMATERIALS AND NANOPHOTONICS

MODEL QUESTION PAPER

Time: 3 Hours **Maximum marks: 75**

PART A

(Answer any nine questions. Each question carries 5 marks)

1. Write a note on Excitons.
2. Briefly discuss about the variation of density of states with respect to dimension of nanomaterials.

3. Give a short note on Quantum confinement in nanomaterials.
4. What is the working principle of ScaningTunning Microscope (STM)? What are the two working modes of STM.
5. Write a short note on hydrothermal synthesis.
6. Explain Fourier Transform Infrared spectroscopy.
7. Give an account on nanocatalysis.
8. Write a note on fullerene.
9. What is Giant magnetoresistance and Colossal magnetoresistance?
10. Give a brief account of the similarities and differences in the physical description of electrons and photons.
11. Explain how we can design mirrors and waveguides in photonic crystals.
12. Explain principles and applications of fluorescence correlation spectroscopy.

(9×5=45)

PART B

(Answer all questions. Each question carries 15 marks)

13. a. Write a note on physical properties of nanomaterials.

OR

b. Explain two top down methods to synthesize nanomaterials.

14. a. Give the structure and physical properties of carbon nanotubes.

OR

b. What are the principles of Near field microscopy? Explain its usefulness in nanoscience. How can we use surface plasmons in designing a near field microscope?

(2×15=30)