DEPARTMENT OF PHYSICS

Revised Curriculum and Syllabus for
MPhil Programme in
Physics

(with effect from 2019 admissions)

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | Reaccredited by NAAC with A Grade
Affiliated to Mahatma Gandhi University, Kottayam, Kerala
Changanassery, Kottayam, Kerala, India-686101

Acknowledgement

The Board of Studies in MPhil Physics acknowledges the contributions from all members in restructuring the Post Graduate Education in Physics. The abundant support and recommendations from the sub-groups for designing different courses has shaped this curriculum to this present nature.

We thank all for their benevolent support and cooperation to make this venture a success.

For the Board of Studies in Physics,

Dr. Shajo Sebastian

(Chairman)

Board of Studies in Physics

Chairman: Dr Shajo Sebastian, Head, Department of Physics

Vice Chancellor's Nominee

1. Dr. Biju P. R., Associate Professor ,School of Pure and Applied Physics, MG University, Kottayam

External Experts

2. Dr. Antony Joseph , Professor, Department of Physics , University of Calicut, Malappuram
3. Dr. Charles Jose, Assistant Professor, Department of Physics ,CUSAT, Kochi

Corporate Sector

4. Mr. Cecil Augustine, Associate Vice President –Business Development, Rays Future Energy India Pvt. Ltd.

Distinguished Alumni

5. Dr. M T Jose, Scientist 'G', IGCAR, Kalpakkom, Tamilnadu
6. Mr. Manoj N, Senior Sub Divisional Engineer, BSNL, Thiruvalla

Faculty of the Department

1. Dr. Issac Paul
2. Dr. Siby Kurien
3. Dr. Jacob Mathew M
4. Dr. K E Abraham
5. Dr. Gijo Jose
6. Dr. Sajith Mathews T
7. Mr. Ajai Jose
8. Dr. Joshy Jose
9. Mr. Justin John
10. Mr. Benny Joseph
11. Dr. Lijo Jose
12. Dr. Sinu P Mathew
13. Dr. Loji K Thomas

Programme Objectives

This course is structured to equip the students to become effective teachers and researchers in Physics, to contribute to the needs of the society, by providing an environment of learning and knowledge creation through academic rigor and innovation. In fulfilling the degree requirements, a student is expected to undertake course work and also to attend seminars/conferences. This programme provides the students a chance to progress in Physics and extend their horizons of learning capabilities with the help of academic development, seminars, projects, assignments, and the articles of research. The focus of this programme is to prepare students and help them become proficient, for teaching, further higher research, or advanced work in industry.

Programme Outcome

The MPhil is offered by the Department of Physics as a full-time period of research and introduces students to research skills and specialist knowledge. Its main objectives are:

- to give students with relevant experience, at first higher level, the opportunity to carry out focused research in the discipline under close supervision
- to give students the opportunity to acquire or develop skills and expertise relevant to their research interests. a comprehensive understanding of techniques, and a thorough knowledge of the literature, applicable to their own research;
- demonstrated originality in the application of knowledge, together with a practical understanding of how research and enquiry are used to create and interpret knowledge in their field
- shown abilities in the critical evaluation of current research and research techniques and methodologies
- demonstrated some self-direction and originality in tackling and solving problems, and acted autonomously in the planning and implementation of research

REGULATIONS FOR MPhil PROGRAMME IN PHYSICS UNDER CREDIT SEMESTER SYSTEM 2019

1. SHORT TITLE

1.1 These Regulations shall be called St. Berchmans College (Autonomous) Regulations (2019) governing MPhil programmes under the Credit Semester System.

1.2 These Regulations shall come into force with effect from the academic year 2019 - 20 onwards.

2. SCOPE

2.1 The regulation provided herein shall apply to all MPhil programmes conducted by St. Berchmans College (Autonomous) with effect from the academic year 2019 - 20.

3. DEFINITIONS

3.1 ‘University’ means Mahatma Gandhi University, Kottayam, Kerala.

3.2 ‘College’ means St. Berchmans College (Autonomous).

3.3 There shall be an Academic Committee nominated by the Principal to look after the matters relating to the MPhil programme.

3.4 ‘Academic Council’ means the Committee consisting of members as provided under section 107 of the University Act 2014, Government of Kerala.

3.5 ‘Parent Department’ means the Department, which offers the particular MPhil programme.

3.6 ‘Department Council’ means the body of all teachers of a Department in the College.

3.7 ‘Faculty Mentor’ is a teacher nominated by a Department Council to coordinate the continuous evaluation and other academic activities of the MPhil programme undertaken in the Department.

3.8 ‘Programme’ means the entire course of study and examinations.

3.9 ‘Duration of Programme’ means the period of time required for the conduct of the programme. The duration of an MPhil programme shall be two (2) semesters.

3.10 ‘Semester’ means a term consisting of a minimum 90 working days, inclusive of tutorials, examination days and other academic activities within a period of six months.

3.11 ‘Course’ means a segment of subject matter to be covered in a semester. Each Course is to be designed under lectures/tutorials/laboratory/seminar/project/practical/ assignments/evaluation etc., to meet effective teaching and learning needs.

3.12 ‘Course Teacher’ means the teacher who is taking classes on the course.

3.13 ‘Elective Course’ means a course, which can be substituted, by equivalent course from the same subject and the number of courses required to complete the programme shall be decided by the respective Board of Studies.

3.14 ‘Project’ means a regular research work with stated credits on which the student conducts research under the supervision of a teacher in the parent department/any appropriate research centre in order to submit a report on the project work as specified.

3.15 ‘Dissertation’ means a minor thesis to be submitted at the end of a research work carried out by each student on a specific area.

3.16 ‘Plagiarism’ is the unreferenced use of other authors’ material in dissertations and is a serious academic offence.

3.17 ‘Seminar’ means a lecture expected to train the student in self-study, collection of relevant matter from books and Internet resources, editing, document writing, typing and presentation.

3.18 ‘Improvement Examination’ is an examination conducted to improve the performance of students in the courses of a particular semester.

3.19 ‘Supplementary Examination’ is an examination conducted for students who fail in the courses of a particular semester.

3.20 The minimum credits, required for completing the programme is forty (40).

3.21 'Credit' (C) of a course is a measure of the weekly unit of work assigned for that course in a semester.

3.22 'Course Credit': One credit of the course is defined as a minimum of one (1) hour lecture/minimum of two (2) hours lab/field work per week for eighteen (18) weeks in a semester. The course will be considered as completed only by conducting the final examination.

3.23 'Grade' means a letter symbol (A, B, C etc.) which indicates the broad level of performance of a student in a course/semester/programme.

3.24 'Grade Point' (GP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.25 'Credit Point' (CP) of a course is the value obtained by multiplying the grade point (GP) by the credit (C) of the course.

3.26 'Semester Grade Point Average' (SGPA) of a semester is calculated by dividing total credit points obtained by the student in a semester by total credits of that semester and shall be rounded off to two decimal places.

3.27 'Cumulative Grade Point Average' (CGPA) is the value obtained by dividing the sum of credit points in all the courses obtained by the student for the entire programme by the total credits of the whole programme and shall be rounded off to two decimal places.

3.28 'Institution average' is the value obtained by dividing the sum of the marks obtained by all students in a particular course by the number of students in respective course.

3.29 'Weighted Average Score' means the score obtained by dividing sum of the products of marks secured and credit of each course by the total credits of that semester/programme and shall be rounded off to two decimal places.

3.30 First, Second and Third position shall be awarded to students who come in the first three places on the basis of CGPA secured in the programme in the first chance itself.

4. PROGRAMME STRUCTURE

4.1 The MPhil degree shall have the status of an intermediate degree between the postgraduate degree and the doctoral degree. The programme shall have both course work and project.

4.2 The programme shall include two types of courses; core courses and elective courses. There shall be a project/research work to be undertaken by all students. The programme will also include assignments, seminars, practical, viva-voce etc., if they are specified in the curriculum.

4.3 Total credits for a programme is forty (40).

4.4 **Research Guide**

Each student will be assigned to a Research Guide by the concerned Head of the Department and programme director. The students can also select a supervisor from a research field attached to their postgraduate degree. The student will choose the topic of his research based on the advice of the Research Guide. The person under whom a candidate is registered for the MPhil programme shall be required to possess PhD degree in the concerned discipline and working in any of the teaching departments of the college or in any of the affiliated colleges/recognized research institutions and recognized by the University as a research supervisor. The candidates are permitted to have a co-guide(s) with the recommendation of the guide. The number of candidates permitted to register under a supervisor at any point of time is determined by the rules and regulations of Mahatma Gandhi University which may vary from time to time.

4.5 **Evaluations**

The evaluation of each course shall contain two parts.

i Internal or In-Semester Assessment (ISA)

ii External or End-Semester Assessment (ESA)

Both ISA and ESA shall be carried out using indirect grading. Marks for ISA is 30 and ESA is 70. The marks for ISA and ESA are given below.

Course	Marks		Total	Credits
	ISA	ESA		
Course I	30	70	100	5
Course II	30	70	100	5
Course III	30	70	100	5
Course IV	30	70	100	5
		Total	**400**	**20**

4.6 **In-semester assessment of theory courses**

The in-semester assessment include the following components:

Component	Marks
Assignment	10
Seminar	10
Two test papers	10
Total	**30**

4.7 **Assignments**

Every student shall submit at least one assignment as an internal component for every course.

4.8 **Seminar**

Every student shall deliver one seminar as an internal component for each course. The seminar is expected to train the student in self-study, collection of relevant matter from the books and internet resources, editing, document writing, typing and presentation.

4.9 **In-semester examination**

Every student shall undergo at least two in-semester examinations as internal component for each theory course.

4.10 To ensure transparency of the evaluation process, the ISA mark awarded to the students in each course in a semester shall be published on the notice board according to the schedule in the academic calendar published by the College. There shall not be any chance for improvement for ISA. The course teacher and the faculty mentor shall maintain the academic record of each student registered for the course which shall be forwarded to the office of the Controller of Examinations through the Head of the Department and a copy shall be kept in the office of the Head of the Department for at least two years for verification.

4.11 **End-semester assessment**

The end-semester examination shall be conducted by the College.

4.12 The end-semester examinations for theory courses shall be conducted at the end of each semester. There shall be one end-semester examination of three (3) hours duration in each lecture based course.

4.13 The question paper should be strictly on the basis of model question paper set by Board of Studies.

4.14 A question paper may contain short answer type, short essay type questions and long essay type questions.

4.15 Question Pattern for external theory examination shall be,

Section	Type	No. of Questions to be Answered	Mark for Each Question	Total Marks
A	Short Answer	5 out of 8	3	15
B	Short Essay	3 out of 5	5	15
C	Essay	4 out of 4	10	40
	Grand Total	**12 out of 17**	**-**	**70**

Section A: A minimum of two questions must be asked from each unit of the course.

Section B: This section is fully dedicated to solving problems/derivation from the course concerned. A minimum of one problem from each unit is required. The problems need not always be of numerical in nature.

Section C: This section will have four questions (essay questions). Two questions of equal standard must be asked from each unit with internal option.

4.16 **Dissertation**

The candidate shall submit three copies and one soft copy of the dissertation to the Controller of Examinations. The candidate shall give a pre-submission presentation on his/her dissertation work at the department before submitting the dissertation. The presentation shall be evaluated by a committee consisting of Head of the Department, Guide and one faculty member nominated by Head of the department.

The external evaluation of the dissertation shall done by an external examiner appointed by controller of examinations. The minimum marks for pass for dissertation and viva voce will be 50%. If the candidate secures less than 50% marks the candidate shall be advised to revise the dissertation based on the suggestions made by the examiners and resubmit the dissertation, within a period of six months. The revised dissertation shall be sent to the same examiner who evaluated the dissertation at the first appearance of the candidate.

A student, who fails to submit the dissertation within the stipulated time (12 months from the date of commencement of classes) on justifiable reasons, shall be permitted to submit the dissertation within a maximum period of two (2) years with prior permission from the Principal. The dissertation shall be evaluated only along with the next batch. The components for project evaluation are given below.

	Marks		**Total**	**Credit**
	ISA	**ESA**		
Pre-Submission Seminar	50	-	50	16
Dissertation	-	150	150	
Viva Voce Based on Dissertation	-	100	100	4
Total			**300**	**20**

4.17 For all courses an indirect grading system based on a seven (7) point scale according to the percentage of marks (ISA + ESA) is used to evaluate the performance of the student in that course. The percentage shall be rounded mathematically to the nearest whole number.

Percentage of Marks	Grade	Performance	Grade Point
95 and above	S	Outstanding	10
85 to below 95	A+	Excellent	9
75 to below 85	A	Very Good	8
65 to below 75	B+	Good	7
55 to below 65	B	Above Average	6
50 to below 55	C	Satisfactory	5
Below 50	F	Pass	4

4.18 **Credit Point**

Credit Point (CP) of a course is calculated using the formula

CP = C × GP

where C is the credit and GP is the grade point

4.19 **Semester Grade Point Average**

Semester Grade Point Average (SGPA) is calculated using the formula

SGPA = TCP/TCS

where TCP is the total credit point of all the courses in the semester and TCS is the total credits in the semester

GPA shall be rounded off to two decimal places.

4.20 **Cumulative Grade Point Average**

Cumulative Grade Point Average (CGPA) is calculated using the formula

CGPA = TCP/TC

where TCP is the total credit point of all the courses in the whole programme and TC is the total credit in the whole programme

GPA shall be rounded off to two decimal places.

Grades for the different courses, semesters, Semester Grade Point Average (SGPA) and grades for overall programme, Cumulative Grade Point Average (CGPA) are given based on the corresponding Grade Point Average (GPA) as shown below:

CGPA	Grade	Performance
9.5 and above	S	Outstanding
8.5 to below 9.5	A+	Excellent
7.5 to below 8.5	A	Very Good
6.5 to below 7.5	B+	Good
5.5 to below 6.5	B	Above Average
5 to below 5.5	C	Satisfactory
Below 5	F	Failure

4.21 A separate minimum of 40% marks each in ISA and ESA and aggregate minimum of 50% are required for a pass for a course. For a pass in a programme, a separate minimum of grade ‘C’ is required for all the individual courses.

5. SUPPLEMENTARY/IMPROVEMENT EXAMINATION

Supplementary/improvement examinations for theory courses in the first semester shall be conducted in the second semester.

6. ATTENDANCE

6.1 The minimum requirement of aggregate attendance during a semester for appearing the end semester examination shall be 75%. Condonation of shortage of attendance to a maximum of ten

(10) days in a semester and once during the whole period of the programme may be granted by the College. This condonation shall not be counted for internal assessment.

6.2 Benefit of attendance may be granted to students representing the College, University, State or Nation in Sports, NCC, NSS or Cultural or any other officially sponsored activities such as College union/University union activities etc., on production of participation/attendance certificates, within one week from competent authorities, for the actual number of days participated, subject to a maximum of ten (10) days in a semester, on the specific recommendations of the Faculty Mentor and Head of the Department.

6.3 A student who does not satisfy the requirements of attendance shall not be permitted to appear in the end-semester examinations.

6.4 Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch after readmission.

7. BOARD OF STUDIES AND COURSES

7.1 The Board of Studies concerned shall design all the courses offered in the MPhil programme. The Boards shall design and introduce new courses, modify or re-design existing courses and replace any existing courses with new/modified courses to facilitate better exposure and training for the students.

7.2 The syllabus of a programme shall contain programme objectives and programme outcome.

7.3 The syllabus of a course shall include the title of the course, course objectives, course outcome, contact hours, the number of credits and reference materials.

7.4 Each course shall have an alpha numeric code which includes abbreviation of the course in two letters, semester number, course code and serial number of the course.

7.5 Every programme conducted under Credit Semester System shall be monitored by the Academic Council.

8. REGISTRATION

8.1 A student who registers his/her name for the external exam for a semester will be eligible for promotion to the next semester.

8.2 A student who has completed the entire curriculum requirement, but could not register for the Semester examination can register notionally, for getting eligibility for promotion to the next semester.

8.3 A student may be permitted to complete the programme, on valid reasons, within a period of four (4) continuous semesters from the date of commencement of the first semester of the programme

9. ADMISSION

9.1 The admission to MPhil programme shall be as per the rules and regulations of the College/University.

9.2 The eligibility criteria for admission shall be as announced by the College/University from time to time.

9.3 Separate rank lists shall be drawn up for seats under reservation quota as per the existing rules.

9.4 There shall be an academic and examination calendar prepared by the College for the conduct of the programmes.

9.5 The admission shall be based on the performance of the candidate in a written test and interview conducted by the college.

1.1 Admission will be made based on the total marks obtained in the qualifying examination, written test and interview in the following ratio.

Qualifying examination (Master’s degree) – 50 Marks

Written test – 40 Marks

Interview – 10 Marks

10. ADMISSION REQUIREMENTS

10.1 Candidates for admission to the first semester of the MPhil programme shall be required to have passed an appropriate postgraduate degree examination of Mahatma Gandhi University or any University or authority, duly recognized by the Academic council of Mahatma Gandhi University as equivalent thereto.

11. MARK CUM GRADE CARD

11.1 The College under its seal shall issue to the students, a Mark cum Grade Card on completion of each semester, which shall contain the following information.

i. Name of the Student
ii. Register Number
iii. Photo of the Student
iv. Degree
v. Programme
vi. Semester and Name of the Examination
vii. Month and Year of Examination
viii. Faculty
ix. Course Code, Title and Credits of each course opted in the semester
x. Marks for ISA, ESA, Total Marks (ISA + ESA), Maximum Marks, Letter Grade, Grade Point (GP), Credit Point (CP) and Institution Average in each course opted in the semester
xi. Total Credits, Marks Awarded, Credit Point, SGPA and Letter Grade in the semester
xii. Weighted Average Score
xiii. Result

11.2 The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the entire programme including those taken over and above the prescribed minimum credits for obtaining the degree. The final Mark cum Grade Card shall show the CGPA and the overall letter grade of a student for the entire programme.

12. AWARD OF DEGREE

The successful completion of all the courses with 'C' grade shall be the minimum requirement for the award of the degree.

13. MONITORING COMMITTEE

There shall be a Monitoring Committee constituted by the Principal to monitor the internal evaluation conducted by the College. The Course Teacher, Faculty Mentor, and the College Coordinator should keep all the records of the continuous evaluation, for at least a period of two years, for verification.

14. GRIEVANCE REDRESS COMMITTEE

14.1 In order to address the grievance of students relating to ISA, a two-level Grievance Redress mechanism is envisaged.

14.2 A student can approach the upper level only if grievance is not addressed at the lower level.

14.3 Department level: The Principal shall form a Grievance Redress Committee in each Department comprising of course teacher and one senior teacher as members and the Head of the Department as Chairman. The Committee shall address all grievances relating to the internal assessment of the students.

14.4 College level: There shall be a College level Grievance Redress Committee comprising of Faculty Mentor, two senior teachers and two staff council members (one shall be an elected member) and the Principal as Chairman. The Committee shall address all grievances relating to the internal assessment of the students.

15. TRANSITORY PROVISION

Notwithstanding anything contained in these regulations, the Principal shall, for a period of three years from the date of coming into force of these regulations, have the power to provide by order that these regulations shall be applied to any programme with such modifications as may be necessary.

PROGRAMME STRUCTURE

Course Code	Course Title	Total Hours	Credit	ISA	ESA	Total
Semester I						
BPPH101	Research Methodology	90	5	30	70	100
BPPH102	Theoretical Physics	90	5	30	70	100
BPPH103	General Physics	90	5	30	70	100
	Elective Course	90	5	30	70	100
	Total	**360**	**20**	**120**	**280**	**400**
Semester II						
BPPH2PJ	Project	288	16	50	150	200
BPPH2VV	Viva Voce	72	4	-	100	100
	Total	**360**	**20**	**50**	**250**	**300**
	Grand Total		**40**	**170**	**530**	**700**

ELECTIVE COURSES

No.	Course Code	Course Title
1	BPPH1E01	Thin Film Technology
2	BPPH1E02	Astrophysics and Cosmology
3	BPPH1E03	Nonlinear Dynamics and Computational Mathematics
4	BPPH1E04	Nanoscience and Nanotechnology
5	BPPH1E05	Plasma Physics

SEMESTER I

BPPH101: RESEARCH METHODOLOGY

Total Hours: 90

Credit: 5

Course Objective

The primary objective of this course is to develop a research orientation among the scholars and to acquaint them with fundamentals of research methods. Specifically, the course aims at introducing them to the basic concepts used in research and to scientific social research methods and their approach.

- To gain familiarity with a phenomenon or to achieve new insights into it (studies with this object in view are termed as exploratory or formulative research studies)
- To portray accurately the characteristics of a particular individual, situation or a group(studies with this object in view are known as descriptive research studies)
- To determine the frequency with which something occurs or with which it is associated with something else (studies with this object in view are known as diagnostic research studies)
- To test a hypothesis of a causal relationship between variables (such studies are known as hypothesis-testing research studies).

Course Outcome

On satisfying the requirements of this course, students will have the knowledge and skills to:

- To develop understanding of the basic framework of research process.
- To develop an understanding of various research designs and techniques.
- To identify various sources of information for literature review and data collection.
- To develop an understanding of the ethical dimensions of conducting applied research.
- Appreciate the components of scholarly writing and evaluate its quality.
- Understanding and hands own training important software used in research.
- Knowledge about the principles, working and applications of Major characterization techniques
- Knowledge about Statistical techniques used in research.

Module 1: General Aspects of Research (22hrs)

Research literature survey- Primary, secondary and tertiary sources- Information search using digital library and internet - Ideas of theoretical, experimental and computational research methods. Research communications-different categories and formats-paper preparation for scientific journals. Environmental Impacts - Ethical Issues – Ethical Committees – Commercialization – copy right – royalty – Intellectual Property rights and patent law – Track Related aspects of intellectual property Rights – Reproduction of published material – Plagiarism – Citation and Acknowledgement – Reproducibility and accountability. Use of Internet in Research – Websites, searches Engines, E-journal and E-Library: INFLIBNET.

Module 2: Software Analysis (23hrs)

MS office and its application in Research – MS Word, MS Power point and MS Excel, LATEX documents - preparation of theses and dissertations - conference presentations in oral and poster forms.

Matlab programming: Matrices and vectors, Scripts and functions, Linear Algebra, Curve fitting and interpolation, data analysis, Ordinary differential equations, Graphics, Math toolbox

Python programming basics: Strings-numbers and operators-variables-functions, Classes and objects-organizing programs-files and directories-other features of Python language.

Line Shapes in Spectroscopy- Lorenzian and Gaussian, Fitting of the spectra. (curve fitting) Deconvolution of spectrum, Derivative peak shapes. Some examples of generating spectra and analysis of spectra by taking examples of X-ray photoelectron spectra. Software/analysis using Origin and Easy plot

Module 3: Major Characterization Techniques (23hrs)

Noise and Signal handling- Signal to noise ratio, Johnson Noise, Shot noise, Means of reducing noise. Grounding - shielding, pre amplifier, Considerations sampling theorem, filters - ADCs/DACs, Resolution of spectrometer/ instrument (general), Resolving power and influence of different experimental parameters on it. Sensitivity of Measurement. Accuracy of measurements.

Review of Atomic Spectroscopy. UV-vis-, NIR, Molecular vibration spectroscopy, Rotational spectroscopy, Bond analysis, Raman spectroscopy, IR, XPS, Mass Spectrometer spectra, X-ray diffraction principles, Intensity dependence Rietveld analysis For powder diffraction. Particle size determination using Scherrer formula Analysis, Single crystal XRD.

Microstructure analysis, Scanning electron and Transmission electron Microscopy, EDAX Field emission microscopy, scanning Tunneling microscopy, Atomic force microscopy. Magnetic measurements – VSM analysis.

Module 4: Statistical Data Analysis (22hrs)

Error analysis, statistical data analysis on data in physics contest, Measures of central tendency, measures of deviations, probability distribution, Binomial distribution, Poisson distribution, Lorentz distribution, Gaussian distribution, Chi-Square test-association between variables, Pearson correlation, Spearman correlation, prediction of values, simple linear regression, non parametric regression, Monte Carlo methods.

Reference

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))
5. Numerical analysis - Francis Scheid, Schum's Outlines, Tata McGraw-Hill Publishing Company Limited.
6. Computer oriented numerical methods-V. Rajaraman, Prentice Hall of India Private limited
7. Getting Started with MATLAB 7: A Quick Introduction for Scientists and Engineers, Rudra Pratap, Oxford University Press.
8. Numerical heat transfer, Suhas V Patankar, Hemisphere Publication Corporation
9. Taylor, John R. An introduction to error analysis, - the study of uncertainties of physical measurements. University Science Books, 1982.

BPPH102: THEORETICAL PHYSICS

Total Hours: 90

Credit: 5

Course Objective:

- To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses.
- The course aims to develop an understanding of Lagrangian and Hamiltonian formulation, which allow for simplified treatments of many complex problems in classical mechanics and provides the foundation for the modern understanding of dynamics.
- To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method and provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences.
- An advanced level course in Quantum mechanics, which objects to teach about various approximation methods in physics to calculate the approximate values of energy for various systems.

Course Outcome:

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Mathematical structure of the governing laws in physics will be revealed
- They will also have an appreciation of generalized functions, their calculus and applications
- The analytical problem solving skills will be extended to a general framework.
- Understanding of advanced level mathematical and geometrical structure of classical mechanics is implied.
- Students will gain a range of techniques employing the Laplace and Fourier Transforms in the solution of ordinary and partial differential equations.
- Geometrical perception of 3 dimensional space will be generalised to n-dimensional non-Euclidean space.
- Apply Maxwell's equations to a variety of problems involving time dependent phenomena.
- Solve problems involving the propagation and scattering of electromagnetic waves in a variety of media.
- Demonstrate an understanding of the characteristics of electromagnetic radiation.

- Have a good understanding of Special Relativity, especially as applied to electrodynamics.
- Have a deep understanding of the mathematical foundations of quantum mechanics
- Understand the effect of symmetries in quantum mechanics.
- Be able to solve the Schrodinger equation using various approximation methods.
- A working knowledge of non-relativistic and relativistic quantum mechanics including time-dependent perturbation theory, scattering theory, relativistic wave equations, and second quantization.
- The ability to critically understand and evaluate modern research utilizing quantum theory in condensed matter, nuclear and particle physics.

Module 1: Mathematical Physics (23hrs)

Dimensional analysis - Vector algebra: Scalar and Vector products, Triple products - vector calculus: Gauss's, Stokes and Green's theorem (no proof) - orthogonal curvilinear coordinates: gradient, divergence, curl and Laplacian in Cartesian, spherical polar and cylindrical co-ordinate systems, Line, Surface and Volume elements - Linear algebra, matrices: Hermitian, unitary AND orthogonal matrices Cayley- Hamilton Theorem, Eigen values and Eigen vectors, Elements of complex analysis, analytic functions, Cauchy-Riemann conditions- Cauchy's integral theorem, Cauchy's integral formula Taylor & Laurent series, poles, ,residues, Calculus of residues-singularities, residue theorem, evaluation of definite integrals, Singular points, evaluation of integrals - one dimensional Dirac delta function, properties and representations. Linear ordinary differential equations of first & second order – Differential equations with variable coefficients: Frobenius method, Special functions (Hermite, Bessel, Laguerre and Legendre functions) - Fourier series, Fourier and Laplace Transforms.

Module 2: Classical Mechanics (22hrs)

Newton's laws - Dynamical systems, Non-inertial frames and pseudo forces, Variational principle - Generalized coordinates - Lagrangian and Hamiltonian formalism and equations of motion - Conservation laws and cyclic coordinates, Generating functions.

Special theory of relativity: Basic postulates- Lorentz transformations, relativistic kinematics: four vectors - mass–energy equivalence. General theory of relativity: Principle of equivalence, Energy momentum tensor, Einstein's Field equations.

Module 3: Quantum Mechanics (22hrs)

Wave-particle duality – Time evolution operator, Wave-function in coordinate and momentum representations, Schrödinger equation (time-dependent and time-independent) – Heisenberg equations of motion, Interaction picture, Time independent perturbation theory and applications.

Eigenvalue problems: particle in a box, harmonic oscillator, Tunneling through a barrier. Commutators and Heisenberg uncertainty principle.

Relativistic quantum mechanics: Klein-Gordon and Dirac equations, Quantization of KG field and Dirac fields.

Module 4: Electrodynamics (23hrs)

Electrostatics: Gauss's law and its applications, Laplace and Poisson equations, boundary value problems - Magnetostatics: Biot-Savart law, Ampere's theorem -Electromagnetic induction -. Maxwell's equations in free space and linear isotropic media - boundary conditions on the fields at interfaces – Electromagnetic waves in free space, Plane waves in conducting and non-conducting medium, Radiation from moving charges and dipoles: retarded potentials, Vector and scalar potentials – gauge transformations: Lorentz gauge, Coulomb Gauge. Magnetism as relativistic phenomena, electromagnetic field tensor, potential formulation of relativistic electrodynamics.

Reference

1. Jon Mathews and R.L. Walker, Mathematical Methods of Physics.
2. George Arfken, Mathematical Methods for Physicists, Fourth (Prism Indian) Edition
3. H. Goldstein, C. Poole and J. Safko, Classical Mechanics
4. N. C. Rana and P. S. Joag, Classical Mechanics
5. Y.K.LIM, LIM SERIES: Problems and solutions on classical mechanics (For Problems)
6. G. Aruldhas, Quantum Mechanics
7. D.J. Griffith, Introduction to Quantum Mechanics
8. V.K. Thankappan, Quantum Mechanics
9. Nouredine Zettili, Quantum mechanics concepts and applications
10. J. D. Jackson, Electrodynamics
11. David J Griffiths, Introduction to Electrodynamics

BPPH103: GENERAL PHYSICS

Total Hours: 90

Credit: 5

Course Objective:

- Use their understanding of the structure, properties, performance, and processing of materials to solve complex engineering problems
- Support the creation of a comprehensive knowledge base for evaluation of the potential risks and benefits of nanotechnology to the environment and to human health and safety.
- Determine stability properties of nonlinear dynamical systems in n dimensions, analytically and numerically analytically and numerically.
- The course is intended only as a first plasma physics course, but includes critical concepts needed for a foundation for further study.

Course Outcome:

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Understanding about the different materials and their properties, application, synthesising methods, etc.
- Expose the students to the development and current relevance of nanoscience
- Students will be able to analyse the behaviour of dynamical systems expressed as either a discrete-time mapping or a continuous-time flow.
- Students will be able to apply the techniques of nonlinear dynamics to physical processes drawn from a variety of scientific and engineering disciplines.
- Students will be able to analyse changes to dynamical systems as system parameters are varied.
- Students will be able to independently research topics in nonlinear dynamics and synthesize this work into coherent written and oral presentations.
- Understanding and through knowledge about the plasma physics its applications.

Module 1: Material Physics (23hrs)

Semi conducting & Ceramic Materials: Semiconductor - Direct and indirect Band gap characteristics, Dilute magnetic semiconductors - Characteristics and applications - Ferroelectric semiconductors, Ceramic superconductors - Applications - High temperature superconductors - Superconducting magnets - High T_C Tapes - Fibre reinforced composites - Composite structure and manufacturing methods.

Polymeric: Polymer semiconductors - Photoconductive polymers - Composition and Structure of Polymers - Electrical conductivity – LEP's design and fabrication - Applications - Mechanical properties.

Optical Materials: Modern imaging materials, piezoelectric, acousto - optic and electro - optic materials - Optical storage materials - Photochromic, thermoplastic and Photoresist materials - materials suitable for detecting toxic gases.

New Materials: Smart materials - Shape memory alloys - Shape memory effect – Martensitic transformation - functional properties - processing – applications, metamaterials.

Module 2: Properties and Growth Techniques of Nanoparticles (22hrs)

Importance of quantum Confinement - Quantum wires and dots, Derivation of density of states of 1D, 2D & Bulk materials.

Metal nanoclusters - Magic numbers-theoretical modeling of nanoparticles Geometric structure-Electronic structure - Reactivity - Fluctuations - magnetic clusters - Bulk to nanotransition. Semiconducting nanoparticles - Optical properties _ photofragmentation - Coulombic explosion, Growth techniques of nanomaterials-Top down VS bottom up technique, Lithographic process and its limitations, Nanolithographic Techniques-Plasma arc discharge, Sputtering, Evaporation, CVD, PLD, MBE, Sol-Gel technique, Electrodeposition, Ball milling, CBD, IBDVLS.

Module 3: Introduction to Nonlinear Dynamics and Chaos (22hrs)

Mathematical models examples - Mathematical implications of Nonlinearity: superposition principle - Linear oscillators & Predictability - Nonlinear oscillators -Resonance and Hysteresis, Autonomous and Nonautonomous systems - Phase plane/space trajectories - stability, attractors AND repellers, - equilibrium points and stability - limit cycle - Bifurcation -Period doubling phenomenon -onset of chaos - Logistic map - Route to chaos,-largest lyapunov exponent, controlling of chaos.

Module 4: Introduction to Plasma Physics (23hrs)

Plasma state - Occurrence of Plasma in nature - Definition of Plasma: concepts of quasi neutrality and collective behaviour - concept of temperature - Debye Shielding - The Plasma parameters - Criteria for Plasma - Applications of Plasma physics (basis ideas).

Single particle motions: uniform E and B fields - Non uniform B and E fields -Summary of guiding centre drifts - magnetic mirrors, Time - varying B and E fields -Adiabatic Invariants. The equation of motion - Fluid drifts perpendicular to B, fluid drifts parallel to B - The plasma approximation.

Reference

1. Frencies F Chen: Introduction to plasma physics and controlled fusion, Vol. 1 Plasma Physics (Plenum press, 1983)
2. Yuri P Raizer, Gas Discharge Physics, Springer-Verlag (2012)
3. Nicholas A Krall and Alvin W Trivelpiece - Principles of plasma physics, McGraw Hillkogkusha Ltd (1986).
4. Richard H. Huddlestone, Stanley L. Leonard- plasma Diagnostic Techniques Academic Press (1965).
5. Verdeyen. J, Laser Electronics, II Edition, Prentice hall 1990.
6. Tumer C. W and Van Duzer. T, Principles of Superconductive Devices and Circuits, 1981.
7. Reynolds and M. Pomeranty in Electroresponsive molecules and polymeric systems Ed. by Skotheim T. Marcel Dekker New York 1991.
8. Yariv A., Principles of Optical Electronics, John Wiley, New York, 1984.
9. Hull. B, and John V, Non- Destructive Testing, McMillan Education Ltd., London, 1988.
10. Funakubo H Shape memory alloys Gordon & Breach, New York 1984.
11. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics, Integrability, chaos and patterns, Springer (2003)
12. Steven H Strogatz, Nonlinear dynamics and Chaos, Perseus Books (2008)
13. Mathematical physics, H.K Das and Rama Varma, S. Chand & company Ltd. (2008).
14. Introduction to nanotechnology - Charles P. Poole, Jr Fraank J Owens
15. Introduction to nanoscience and nanotechnology K. K. Chattopadhyay, A.N. Banerjee
16. Introduction to Magnetic Materials 2nd ed B D Culiity Wiley

ELECTIVE COURSES

BPPH1E01: THIN FILM TECHNOLOGY

Total Hours: 90

Credit: 5

Course Objective:

- The course shall give knowledge on mechanisms and processes for synthesis and microstructural evolution of thin films from the vapour phase. Included is also an overview of methods used for synthesis films and industrial applications.
- Understand the fundamental atomistic mechanisms and processes that control film formation and microstructural evolution.
- Understand the effect of the process conditions on film growth microstructural evolution
- Know the principle, the advantages and the disadvantages of different thin film deposition methods.
- Have insights in possibilities and the importance of different thin films and coatings for a variety industrial applications.

Course Outcome:

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Expose the students to different methods of preparations of thin films
- Understanding about electrical and optical properties of different thin films
- Exposure to vacuum science, various pumps, gauges and thin film deposition techniques.
- Fundamental understanding and applications various lithography techniques

Module 1: Preparation of Thin Films (22hrs)

Spray pyrolytic process – characteristic feature of the spray pyrolytic process - 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. Amorphous thin films - glassy films, Dip coating, spin coating

Module 2: Thickness Measurement and Nucleation and Growth in Thin Film (22hrs)

Thickness measurement: electrical methods - optical interference methods - multiple beam interferometry - Fizeau - FECO methods - Quartz crystal thickness monitor. Theories of thin film nucleation - Four stages of film growth incorporation of defects during growth.

Module 3: Electrical Properties of Metallic Thin Films (23hrs)

Sources of resistivity in metallic conductors - sheet resistance - Temperature coefficient of resistance (TCR) - influence of thickness on resistivity - Hall effect and magneto resistance - Annealing - Agglomeration and oxidation.

Photoconduction -Dielectric properties - dielectric losses - Ohmic contacts - Metal -Insulator and Metal - metal contacts - DC and AC conduction mechanism.

Module 4: Optical Properties of Thin Films and Thin Films Solar Cells (23hrs)

Thin films optics -Theory - Optical constants of thin films - Experimental techniques - Multilayer optical system - interference filters - Antireflection coating ,Thin films solar cells: Role, Progress , and production of thin solar cells - Photovoltaic parameter, Thin film silicon (Poly crystalline) solar cells : current status of bulk silicon solar cells -Fabrication technology - Photo voltaic performance : Emerging solar cells : GaAs and CulnSe.

Reference

1. Fundamentals of Inorganic glasses, Arun K Varsnaya (academic Process)
2. The Physics of amorphous solids, R Zallan (John Willey)
3. Physics of amorphous materials S R Elliot (Longman)
4. Handbook of Thin films Technology: L I Maissel and R Clang.
5. Thin film Phenomena: K L Chopra.
6. Physics of thin films, vol. 12, Ed George Hass and others.
7. Thin films solar cells - K L Chopra and S R Das.
8. Thin films process – J L Visan
9. Vacuum deposition of thin films - L Holland.
10. The use of thin films in physical investigation - J C Anderson
11. Thin films technology - Berry, Koil and Harris

BPPH1E02: ASTROPHYSICS AND COSMOLOGY

Total Hours: 90

Credit: 5

Course Objective:

- Be inspired to continue and share their interest in astronomical advances and discoveries throughout their lives.
- Have a solid grounding in the underlying principles and important conceptual models from core subject areas of astronomy and physics and demonstrate their ability to correctly draw logical conclusions from these principles and models, enabling them to make accurate quantitative predictions in astronomical contexts.
- Understand and have experience using observational and experimental techniques in various areas of astronomy and physics, designing, obtaining, analysing, and interpreting quantitative data.

Course Outcome:

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Apply rigorously the scientific method in the absence of controlled laboratory experiments
- Perform order of magnitude estimates and solve abstract Fermi problems
- List astrophysically relevant radiation mechanisms, and identify them based on their spectral properties
- Discuss the propagation of radiation in a medium
- Qualitatively discuss the structure of a star and its properties
- Discuss the properties of degenerate matter and the outcome of stellar evolution for stars of different mass
- List the components of the interstellar medium and discuss their interactions
- Describe the properties and evolution of different types of galaxies
- Describe the Big Bang cosmological model, and the evidence to support it
- Discuss the experimental support for the existence of dark matter and dark energy

Module 1: Introduction (22hrs)

Celestial Sphere: The altitude-Azimuth Coordiate system, Equatorial co-ordiate system; Celestial objects: Planets, Stars, Galaxies, Milkyway; Distance measurements: Parallalax method, Flux, Luminosity, Magnitude sstem: Absolute and apparent magnitude, distance modulus; Black body radiation, bolometric magnitude, filters, color index; Spectral lines (absorption and emission), spectral classification of stars, M-B velocity distribution, Boltzmann Equations, Saha's ionisation formula, Applications, H-R diagram.

Module 2: Astronomical Instrumentation (22hrs)

Telescopes: basic optics, Rayleigh Criterion, Seeing, Aberrations, Brightness of an Image; Optical Telescopes: Refracting and Reflecting telescopes, Adaptive Optics, Radio Telescopes: Flux density, Interferometry; Atmospheric window in the electromagnetic spectrum: Infrared, UV, X-ray and Gamma ray astronomy.

Astronomical Photometry; Photometer, Light Detectors: Photomultiplier Tubes, PIN photodiodes; Charged Coupled Devices: Operation; Spectroscopy: Review of spectrographs, CCD spectrographs.

Module 3: Stellar and Galaxy Physics (23hrs)

Hydrostatic equilibrium: free fall, virial theorem for stars, equilibrium of a gas of non-relativistic ideal gas particles, virial temperature; Radiative energy transport: mean free path, sun's internal temperature; Equations of stellar structure; Equation of state; Opacity; Energy production: Nuclear reactions, p-p chain, reaction rate, power production in p-p chain, CNO cycle (brief discussion). Solutions of the equations of stellar structure: case of convection.

Structure of Milky-way, Components: the disk, the spheroid, centre, dark halo (from rotation curves), Galaxy demographies: Spiral and ellipticals, galaxy luminosity function. Groups and clusters of galaxies.

Module 4: Cosmology (23hrs)

Metric tensor; Cosmological Principle; FRW metric: scale factor, Hubble's law, The big bang theory, Expanding universe, cosmological redshift; The Friedmann's equations (no derivation) and solutions; Comoving and Hubble horizon, angular diameter and luminosity distances; Evolution of isotropic fluid in expanding universe, Evolution radiation and matter. Epoch of matter radiation equality; Scale factor evolution (during inflation, radiation and matter dominated epochs); CMBR as an observational evidences for big bang (qualitative ideas only); Dark energy; Formation of structures in the universe: Linear growth of perturbations in Newtonian limit, Jeans mass in the expanding universe.

Reference

1. Basic Astrophysics - Dan Maoz.

2. An Introduction to Modern Astrophysics - Bradley W. Caroll, Dale A. Ostlie, Addison-Wesley Publishing Company.
3. Astronomical Photometry - A Text and Handbook for the Advanced Amateur and Professional Astronomer, Arne A Henden and Ronald H Kaitchuck.
4. Handbook of CCD Astronomy - Second edition, STEVE B. HOWELL.
5. Modern Cosmology - Scott Dodelson.
6. Structure formation in the universe- T. Padmanabhan.
7. Stellar Structure and Evolution - Second Edition, Rudolf Kippenhahn, Alfred Weigert, Achim Weiss.

BPPH1E03: NONLINEAR DYNAMICS AND COMPUTATIONAL MATHEMATICS

Total Hours: 90

Credit: 5

Course Objective:

- Modern numerical and analytical methods will be introduced which allow to investigate dynamical systems used as mathematical models in science and engineering. Specific well known and important examples of applications from physics will serve as basis to explain the mathematical techniques.
- Determine stability properties of nonlinear dynamical systems in n dimensions, analytically and numericallyanalytically and numerically.

Course Outcome:

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Students will be able to analyze the behaviour of dynamical systems expressed as either a discrete-time mapping or a continuous-time flow.
- Students will be able to apply the techniques of nonlinear dynamics to physical processes drawn from a variety of scientific and engineering disciplines.
- Students will be able to analyse changes to dynamical systems as system parameters are varied.
- Students will be able to independently research topics in nonlinear dynamics and synthesize this work into coherent written and oral presentations.

Module 1: Linear and Nonlinear Systems (22hrs)

Mathematical models examples - Mathematical implications of Nonlinearity: superposition principle - Linear oscillators and Predictability - Nonlinear oscillators -Resonance and Hysteresis-Linear and nonlinear systems-Determinism, unpredictability and divergence of trajectories.

Module 2: Introduction Chaos (23hrs)

Autonomous and Nonautonomous systems - Phase plane/space trajectories - stability, attractors and repellers, - equilibrium points and stability - limit cycle - Bifurication -Period doubling phenomenon -onset of chaos - Logistic map - Lorentz -systems - Sensitive dependence on initial condition - Routes to Chaos; period doubling, Quasi periodicity, intermittency and crises, chaotic transients and homoclinic orbits.

Module 3: Developments in Chaotic Dynamics (22hrs)

Quantifying Chaos: Time series analysis-estimation of time delay, , Kolmogorov-Sinai Entropy, Fractal dimensions, Correlation dimension, Embedding dimension -largest lyapunov exponent, stochastic resonance, chaotic scattering, controlling of chaos, Quantum mechanics and chaos.

Module 4: Computational Mathematics (23hrs)

Random variable, probability distributions, regression analysis, Higher order differential equations, non-linear differential equations, Coupled differential equations, Runge Kutta methods, finite volume methods, finite difference methods, finite element methods, Monte-Carlo simulation techniques. Programming using Matlab.

Reference

1. M. Lakshmanan and S. Rajasekar, Nonlinear Dynamics, Integrability, chaos and patterns, Springer (2003)
2. Steven H Strogatz, Nonlinear dynamics and Chaos, Perseus Books (2008)
3. Robert C. Hilborn, Chaos and nonlinear dynamics, Oxford (2000).
4. Mathematical physics, H.K Das and Rama Varma, S.Chand & company Ltd. (2008).
5. Fundamentals of statistics, S.C Gupta, Himalaya publishing house (1996)
6. Numerical heat transfer, Suhas V Patankar, Hemisphere Publication Corporation (1980)
7. Methods of computer modeling in engineering & science, volume 1, satya N Atluri, tech Science Press (2005)
8. Monte-Carlo: concepts, algorithms and applications George fishman, springer (2003)
9. Getting Started With Matlab: A Quick Introduction For Scientists And Engineers, Rudra Pratap, Oxford University Press (2009)

BPPH1E04: NANOSCIENCE AND NANOTECHNOLOGY

Total Hours: 90

Credit: 5

Course Objective:

- Support the creation of a comprehensive knowledge base for evaluation of the potential risks and benefits of nanotechnology to the environment and to human health and safety.
- Create and employ means for timely dissemination, evaluation, and incorporation of relevant environmental, health, and safety (EHS) knowledge and best practices.
- Develop the national capacity to identify, define, and responsibly address concepts and challenges specific to the ethical, legal, and societal implications (ELSI) of nanotechnology.
- Incorporate sustainability in the responsible development of nanotechnology.

Course Outcome:

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Expose the students to the development and current relevance of nanoscience
- Train the students to get a fundamental understanding and applications of various microscopy, spectroscopy and XRD techniques
- Fundamental understanding and applications various lithography techniques
- Gain a basic knowledge of near-field optics and exposure to nanophotonics and plasmonics.

Module 1: Properties and Growth Techniques of Nanoparticles (22hrs)

Metal nanoclusters - Magic numbers-theoretical modeling of nanoparticles Geometric structure-Electronic structure - Reactivity - Fluctuations - magnetic clusters - Bulk to nanotransition. Semiconducting nanoparticles - Optical properties - photofragmentation - Coulombic explosion, Growth techniques of nanomaterials Top-down techniques: photolithography, other optical lithography (EUV, X-ray, LIL), particle-beam lithographies (e-beam, focused ion beam), probe lithographies (using AFM, STM, SNOM), Bottom-up techniques: Gas phase methods (Plasma Arcing, Pulsed laser deposition, chemical vapour deposition, molecular beam epitaxy), Liquid phase methods (Sol-gel synthesis), self assembly, self-assembled mono layers, layer-by-layer assembly. Combination of Top-Down and Bottom-up techniques (summary): Pattern replication techniques: soft lithography, nano imprint lithography. Pattern transfer and enhancement techniques: dry etching, wet etching, pattern growth techniques: polymerization.

Module 2: Introductory Quantum Mechanics for Nanoscience (23hrs)

Size effects in smaller systems - increase in response time for miniaturized simple pendulum - Thermal decrease of time constant in smaller systems - Disappearance of friction in highly symmetric molecular systems , Quantum behaviour of nanometric world - Bohrs model of hydrogen atom - Wave particle duality - De Broglie wavelength - Wavefunction associated with an electron – Heisenberg uncertainty principle - Matter waves - wave packet - Schrodinger equation -Applications of Schrodinger equation - Infinite potential well: A confined particle in 1D-Potential step: Reflection tunneling and quantum leak - Specific case of tunneling: Penetration of barrier - Potential box: Trapped particle in 3D:Quantum dot - Electron happed in 2D plane: Nanosheet-Electron moving in lD:Nanowire/rod/belt-One electron atoms: The hydrogen atom - Excitons -Quantum confinement effect in nanomaterials. (Ref: 2, chapter: 5)

Module 3: Electrical Transport in Nanostructures (23hrs)

Electrical conduction in metals - Classical Drude model - Quantum theory: The free electron model, Conduction in insulators/ionic crystals, Electron transport in semiconductors - Conductivity - carrier concentration - Fermi level in intrinsic and extrinsic semiconductors, Various conduction mechanisms in low dimensional systems - Thermionic emission - Field enhanced thermionic emission (Schottky effect) - Field assisted thermionic effect from traps (Poole- Frenkel effect) Arrhenius type thermally activated conduction - Variable range hopping conduction - Polaron conduction . (Ref: 2, Chapter: 4)

Module 4: Magnetic Properties in Fine Particles and Magnetic Experimental Methods (22hrs)

Introduction- Single Domain vs Multi-Domain Behavior. - Coercivity of fine particles Magnetisation Reversal by Wall Motion -Superparamagnetism in fine particles - Superparamagnetisation in Alloys- Measuring Magnetization: Vibrating Sample Magnetometer-Squid magnetometer.

Reference

1. Introduction to Nanoscience and Nanotechnology, K.K. Chattopadhay, A. N. Banerjee PHI India
2. Nano: The Essentials T. Pradeep, TMH 2007

3. Paras N. Prasad, “Nanophotonics”, Wiley-Interscience (2004).
4. Experimental Physics A. Dunlap oxford university press
5. Vacuum deposition of Thin films, L. Holland, Chapman Hall, London
6. Handbook of thin film Technology, L.I Maissel and R. Glang, McGraw Hill
7. Thin film phenomena, K.L Chopra, McGraw Hill, New York
8. Nanoscience, Nanotechnologies and Nanophysics, C. Dupas, P. Houdy & M. Lahmani, Springer-Verlag, (2007).
9. Ben Rogers, S. Pennathur and J. Adams, “Nanotechnology: Understanding small systems”, CRC Press, Boca Raton (2008).
10. Sergey V. Gaponenko, “Introduction to nanophotonics”, Cambridge Univ. Press, Cambridge (2010)
11. D.B. Williams and C.B. Carter, Transmission Electron microscopy: A text book for Materials Science, 2nd edn. Plenum press, New York, (1996)
12. S. Hufner, Photoelectron Spectroscopy: Principles and Applications, 2nd edn. Springer, Heidelberg, (1996)
13. Introduction to Nanotechnology, Charles P. Poole, Jr. And Frank J. Owens, Wiely
14. Semiconductor Nanostructures for Optoelectronic Applications, Todd Steiner, Artech House
15. Nanotechnology 101, John Mongillo, Greenwood Press, (2007).
16. What is What in the Nanoworld A Handbook on Nanoscience and Nanotechnology, Victor E. Borisenko and Stefano Ossicini ,WILEY-VCH Verlag, (2008).

BPPH1E05: PLASMA PHYSICS

Total Hours: 90

Credit: 5

Course Objective:

- Understand the fundamental properties and physical processes that govern plasmas relevant to space physics, laboratory plasmas and controlled fusion
- To introduce the basic concepts and challenges (see statement above) of plasma physics.
- The course will provide a brief revision of key elements of electromagnetic theory. Magnetohydrodynamics (MHD) will be developed and applied, with application of kinetic theory to areas where MHD breaks down.

Course Outcome:

On satisfying the requirements of this course, students will have the knowledge and skills to:

- Idea about Plasma physics and its applications.
- Knowledge about the equilibrium and stability of plasma state.
- Plasma waves and its classifications.
- Understanding about different plasma diagnostic technique.

Module 1: Introduction to Plasmas (22hrs)

Plasma state - Occurrence of Plasma in nature - Definition of Plasma: concepts of quasi neutrality and collective behaviour - concept of temperature - Debye Shielding - The Plasma parameters - Criteria for Plasma - Applications of Plasma physics (basis ideas).

Single particle motions: uniform E and B fields - Non uniform B and E fields -Summary of guiding centre drifts - magnetic mirrors, Time - varying B and E fields -Adiabatic Invariants.

Module 2: Plasma as a Fluid (22hrs)

The equation of motion - Fluid drifts perpendicular to B, fluid drifts parallel to B - The plasma approximation.

Equilibrium and stability: Hydromagnetic Equilibrium - The concept of diffusion of magnetic field into plasma, classification of instabilities: - Two stream Instability - The gravitational instability - Resistive Drift waves - The weibel instability.

Module 3: Waves in Plasma (23hrs)

Representation of waves - Group velocity - plasma Oscillations -Electron Plasma waves - sound waves - Ion waves - Validity of plasma approximation - comparison of ion and Electron waves - Electromagnetic waves with $B_0 = 0$, Experimental applications, Electromagnetic waves perpendicular and parallel to B_0, Experimental consequences, Hydromagnetic waves - Alfven waves, Magnetosonic waves, Summary of Elementary plasma waves - The CMA Diagram.

Module 4: Kinetic Theory (23hrs)

The meaning of f(v) Equations by Kinetic theory - Derivations of the fluid equation –plasma Oscillations and Landau damping - The meaning of Landau Damping - A physical derivation of Landau Damping - BGK and van Kampen modes - Experimental verification – Kinetic effects in a Magnetic field.

Plasma Diagnostics: Electrical methods - Langmuir probes-theory, electronic circuit, different geometry of probes, current - voltage characteristics of single probe and double probe.

Reference

1. Frencies F Chen: Introduction to plasma physics and controlled fusion vol 1 plasma physics (Plenum press, 1983)
2. Yuri P Raizer, Gas Discharge Physics, Springer-Verlag (2012)
3. Nicholas A Krall and Alvin W Trivelpiece - Principles of plasma physics, McGraw Hillkogkusha Ltd (1986).
4. Richard H. Huddlestone, Stanley L. Leonard- plasma Diagnostic Techniques Academic Press (1965).
5. Tanenbaum, B. S. Plasma Physics. New York, NY: McGraw-Hill (1967).
6. Clemmow, P. C., and J. P. Dougherty. Electrodynamics of Particles and Plasmas. New York, NY: Perseus Books (1989).
7. Ichimaru, S. Principles of Plasma Physics - A Statistical Approach. Boston, MA: Addison Wesley Publishing Company (1973).