DEPARTMENT OF

PHYSICS

Curriculum and Syllabus for
Postgraduate Programme in
Physics (Electronics)
Under Credit Semester System
(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

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Acknowledgement

The Board of Studies in Physics (PG) 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)

Members of Board of Studies in Physics

Chairman: Dr Shajo Sebastian, Head of the 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 , Dept 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 from 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

The course objectives of M. Sc. Physics (Electronics) are to:

- Impart higher level knowledge and understanding of physics and technology with a proper knowledge of Electronics and its applications to all branches in Physics
- Prepare the students to successfully compete for employment in Electronics, Manufacturing and Teaching industry.
- Enable students to analyse mathematical models of physical systems for enhancement of system performance and arrive at limitations of physical systems
- Enhance students' ability to develop mathematical models of defined physical systems
- Prepare students to evaluate the soundness of concepts proposed and provide exposure to advanced experimental/theoretical methods for measurement, observation, and fundamental understanding of physical phenomenon/systems.

Programme Outcome

- Develop strong student competencies in Physics and its applications in a technology-rich, interactive environment.
- Develop strong student skills in the research, analysis and interpretation of complex information.
- Acquire deep knowledge in fundamental aspects of all branches of Physics.
- Acquire deep knowledge in the specialized thrust areas like Classical Mechanics, Quantum Mechanics, Mathematical Physics, Electromagnetic Theory, Thermodynamics and Statistical Mechanics, Electronics, Microprocessor & Electronic Instrumentation, Condensed Matter Physics, Nuclear and Particle Physics, Materials Science etc.,

REGULATIONS FOR POSTGRADUATE (PG) PROGRAMMES UNDER CREDIT SEMESTER SYSTEM (SB-CSS-PG) 2019

1. SHORT TITLE

1.1 These Regulations shall be called St. Berchmans College (Autonomous) Regulations (2019) governing postgraduate programmes under Credit Semester System (SB-CSS-PG).

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 regular postgraduate programmes, MA/MSc/MCom, 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 SB-CSS-PG system.

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 a particular postgraduate 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 Postgraduate 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 a postgraduate programme shall be four (4) 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 or fieldwork/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 'Core Course' means a course that the student admitted to a particular programme must successfully complete to receive the Degree and which cannot be substituted by any other course.

3.14 '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.

3.15 The elective course shall be either in the fourth semester or be distributed among third and fourth semesters.

3.16 'Audit Course' means a course opted by the students, in addition to the compulsory courses, in order to develop their skills and social responsibility.

3.17 'Extra Credit Course' means a course opted by the students, in addition to the compulsory courses, in order to gain additional credit that would boost the performance level and additional skills.

3.18 Extra credit and audit courses shall be completed by working outside the regular teaching hours.

3.19 There will be optional extra credit courses and mandatory audited courses. Successful completion of mandatory audited courses in the respective semester is necessary for the declaration of the result of the candidate from that semester onwards. If a candidate fails to complete the mandatory course, he/she shall complete the same along with the next batch. This provision shall be availed only once during the tenure of the programme. The completion of optional courses is not mandatory for a pass in the programme. The details of the extra credit and audit courses are given below.

Semester	Course	Type
I	Course on Mendeley Reference Management Software	Optional, Extra credit Grades Shall be given
	Course on Basic Life Support System and Disaster Management	Compulsory, Audit Grades Shall be given
First summer vacation	Internship/Skill Training	Optional, Extra credit Grades Shall be given
Any time during the programme	Oral Presentation in National/International seminar	Optional, Extra credit
	Publication in a recognized journal with ISSN number	

3.20 '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.

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

3.22 'Plagiarism' is the unreferenced use of other authors' material in dissertations and is a serious academic offence.

3.23 '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.

3.24 'Tutorial' means a class to provide an opportunity to interact with students at their individual level to identify the strength and weakness of individual students.

3.25 'Improvement Examination' is an examination conducted to improve the performance of students in the courses of a particular semester.

3.26 'Supplementary Examination' is an examination conducted for students who fail in the courses of a particular semester.

3.27 The minimum credits, required for completing a postgraduate programme is eighty (80).

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

3.29 '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.

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

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

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

3.33 '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.

3.34 '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.

3.35 '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.

3.36 '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.

3.37 'Grace Marks' means marks awarded to course/courses, in recognition of meritorious achievements of a student in NCC/NSS/ Sports/Arts and cultural activities.

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

4. PROGRAMME STRUCTURE

4.1 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.

4.2 Total credits for a programme is eighty (80). No course shall have more than four (4) credits.

4.3 **Project/dissertation**

Project/research work shall be completed by working outside the regular teaching hours except for MSc Computer Science programme. Project/research work shall be carried out under the supervision of a teacher in the concerned department. A student may, however, in certain cases be permitted to work in an industrial/research organization on the recommendation of the supervisor. There shall be an internal assessment and external assessment for the project/dissertation. The external evaluation of the Project/Dissertation shall be based on the individual presentation in front of the expert panel.

4.4 **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. The ISA:ESA ratio is 1:3. Marks for ISA is 25 and ESA is 75 for all courses.

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

The components for ISA are given below.

Component	Marks
Attendance	2
Viva	3
Assignment	4
Seminar	4
Class test	4
Model Exam	8
Total	**25**

4.6 Attendance evaluation of students for each course shall be as follows:

% of Attendance	Marks
Above 90	2
75 - 90	1

4.7 **Assignments**

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

4.8 **Seminar**

Every student shall deliver one seminar as an internal component for every 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 one as class test and second as model examination as internal component for every 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 **In-semester assessment of practical courses**

The internal assessment of practical courses shall be conducted either annually or in each semester. There shall be one in-semester examination for practical courses. The examination shall be conducted annually or in each semester. The components for internal assessment is given below.

Component	Marks
Attendance	2
Lab Test	15
Viva-Voce	5
Record	3
Total	**25**

Attendance evaluation of students for each course shall be as follows:

% of Attendance	Marks
Above 90	2
75 - 90	1

4.12 **End-semester assessment**

The end-semester examination in theory and practical courses shall be conducted by the College.

4.13 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.

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

4.15 A question paper may contain short answer type/annotation, short essay type questions/problems and long essay type questions. Marks for each type of question can vary from programme to programme, but a general pattern may be followed by the Board of Studies.

Physics

Section	Total No. of Questions	Questions to be Answered	Marks	Total Marks for the Section
A	14	10	2	20
B	8	5	5	25
C	5	3	10	30
			Maximum	**75**

4.16 Photocopies of the answer scripts of the external examination shall be made available to the students for scrutiny as per the regulations in the examination manual.

4.17 Practical examination shall be conducted annually or in each semester. Practical examination shall be conducted by one external examiner and one internal examiner. The question paper setting and evaluation of answer scripts shall be done as per the directions in the examination manual of the College. The duration of practical examination shall be decided by the Board of Studies.

4.18 Project/Dissertation evaluation shall be conducted at the end of the programme. Project/Dissertation evaluation shall be conducted by one external examiner and one internal examiner. The components and mark division for internal and external assessment shall be decided by the respective Board of Studies.

Components of Project Evaluation	Marks
Internal Evaluation	25
Dissertation (External)	50
Viva-Voce (External)	25
Total	**100**

4.19 Comprehensive viva-voce shall be conducted at the end of the programme. Viva-voce shall be conducted by one external examiner and one internal examiner. The viva-voce shall cover questions from all courses in the programme. There shall be no internal assessment for comprehensive viva-voce. The maximum marks for viva-voce is one hundred (100).

4.20 For all courses (theory and practical) 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
45 to below 55	C	Satisfactory	5
40 to below 45	D	Pass	4
Below 40	F	Failure	0

4.21 **Credit Point**

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

$$\mathbf{CP = C \times GP}$$

where C is the credit and GP is the grade point

4.22 **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.

4.23 **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:

GPA	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
4.5 to below 5.5	C	Satisfactory
4 to below 4.5	D	Pass
Below 4	F	Failure

4.24 A separate minimum of 40% marks each in ISA and ESA (for theory and practical) and aggregate minimum of 40% are required for a pass for a course. For a pass in a programme, a separate minimum of grade 'D' is required for all the individual courses.

5. SUPPLEMENTARY/IMPROVEMENT EXAMINATION

5.1 There will be supplementary examinations and chance for improvement. Only one chance will be given for improving the marks of a course.

5.2 There shall not be any improvement examination for practical courses and examinations of the final year.

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 subject to a maximum of two times during the whole period of postgraduate 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 programme. The Board 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 eight (8) continuous semesters from the date of commencement of the first semester of the programme

9. ADMISSION

9.1 The admission to all PG programmes 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.

10. ADMISSION REQUIREMENTS

10.1 Candidates for admission to the first semester of the PG programme through SB-CSS-PG shall be required to have passed an appropriate 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
xiv. Credits/Grade of Extra Credit and Audit Courses

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 'D' 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 REDRESSAL COMMITTEE

14.1 In order to address the grievance of students relating to ISA, a two-level Grievance Redressal 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 Redressal 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 Redressal 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.

REGULATIONS FOR EXTRACURRICULAR COURSES, INTERNSHIP AND SKILL TRAINING

COURSE ON BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

i. The course on BLS & DM shall be conducted by a nodal centre created in the college.
ii. The nodal centre shall include at least one teacher from each department. A teacher shall be nominated as the Director of BLS & DM.
iii. The team of teachers under BLS & DM shall function as the trainers for BLS & DM.
iv. The team of teachers under BLS & DM shall be given intensive training on Basic Life Support System and Disaster Management and the team shall be equipped with adequate numbers of mannequins and kits for imparting the training to students.
v. Each student shall under go five (5) hours of hands on training in BLS & DM organised by the Centre for BLS & DM.
vi. The training sessions shall be organised on weekends/holidays/vacation during the first semester of the programme.
vii. After the completion of the training, the skills acquired shall be evaluated using an online test and grades shall be awarded.
viii. Nodal centre for BLS & DM shall conduct online test and publish the results.
ix. Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch. There shall be two redo opportunity.
x. For redressing the complaints in connection with the conduct of BLS & DM students shall approach the Grievance Redress Committee functioning in the college.

COURSE ON MENDELY REFERENCE MANAGEMENT SOFTWARE

i. College shall arrange workshop with hands on training in Mendely reference management software during the first semester.
ii. Students completing the course can enrol for an evaluation and those who pass the evaluation shall be given one credit.

INTERNSHIP/SKILL TRAINING PROGRAMME

i. Postgraduate student can undergo an internship for a minimum period of five days (25 hours) at a centre identified by the concerned department. In the case of disciplines where internship opportunities are scanty (e.g. Mathematics) special skill training programmes with duration of five days (25 hours) shall be organised.
ii. Each department shall identify a teacher in charge for internship/skill training programme.
iii. The department shall select institutions for internship/organising skill training programme.
iv. Internship/skill training programme shall be carried out preferably during the summer vacation following the second semester or during the Christmas vacation falling in the second semester or holidays falling in the semester.
v. At the end of the stipulated period of internship each student shall produce an internship completion cum attendance certificate and an illustrated report of the training he/she has underwent, duly certified by the tutor and Head of the institution where the internship has been undertaken.
vi. Students undergoing skill training programme shall submit a training completion cum attendance certificate and a report of the training he/she has underwent, duly certified by the trainer, teacher co-ordinator of the programme from the concerned department and the head of the department concerned.
vii. Upon receipt of the internship completion cum attendance certificate and illustrated report of the training or a training completion cum attendance certificate and a report of the training, the teacher in charge of internship/skill training programme shall prepare a list of students who have completed the internship/skill training programme and a list of students who failed to complete the programme. Head of the department shall verify the lists and forward the lists to the Controller of Examinations.

PAPER PRESENTATION

i. During the period of the programme students shall be encouraged to write and publish research/review papers.
ii. One research/review paper published in a UGC approved journal or oral presentation in an international/national seminar which is later published in the proceedings shall fetch one credit.

VIRTUAL LAB EXPERIMENTS/MOOC COURSES

i. During the tenure of the programme, students shall be encouraged to take up Virtual Lab Experiments and/or MOOC Courses.
ii. College shall arrange dedicated infrastructure for taking up Virtual Lab experiments and/or MOOC courses.
iii. There shall be a Nodal Officer and a team of teachers to coordinate the logistics for conducting Virtual Lab experiments and MOOC courses and to authenticate the claims of the students regarding the successful completion of the Virtual Lab experiments and or MOOC courses.
iv. Students who are desirous to do Virtual Lab experiments and or MOOC courses shall register with the Nodal Officer at the beginning of the experiment session/MOOC course. Students also shall submit proof of successful completion of the same to the Nodal officer.
v. Upon receipt of valid proof, the Nodal Officer shall recommend, to the Controller of Examinations, the award of extra credits. In the case of Virtual Lab experiments, 36 hours of virtual experimentation shall equal one credit and in the case of MOOC courses 18 hours of course work shall equal one credit.

Model Mark cum Grade Card

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Changanassery, Kottayam, Kerala, India-686101

MARK CUM GRADE CARD

Date:

Name of the Candidate :
Permanent Register Number (PRN) :
Degree :
Programme :
Name of Examination :
Faculty :

Photo

Cours e Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CP)	Institution Average	Result
			ISA		ESA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					
	Total SGPA: SG: WAS: ***End of Statement***												

*WAS: Weighted Average Score

Entered by:

Verified by:

Controller of Examinations **Principal**

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Changanassery, Kottayam, Kerala, India - 686101, Tel: 91-481-2420025, 9961231314
E-mail: sbc@sbcollege.org Web: www.sbcollege.ac.in

CONSOLIDATED MARK CUM GRADE CARD

Name of the Candidate :

Permanent Register Number (PRN) :

Degree :

Programme :

Faculty :

Date :

Photo

Course Code	Course Title	Credits (C)	Marks						Grade Awarded (G)	Grade Point (GP)	Credit Point (CP)	Institution Average	Result
			ISA		ESA		Total						
			Awarded	Maximum	Awarded	Maximum	Awarded	Maximum					
SEMESTER I													
SEMESTER II													
SEMESTER III													

SEMESTER IV													
	End of Statement												

PROGRAMME RESULT

Semester	Marks Awarded	Maximum Marks	Credit	Credit Point	SGPA	Grade	WAS	Month & Year of Passing	Result
I II III IV									
Total					**FINAL RESULT: CGPA = ; GRADE = ;WAS =**				

*** Separate grade card is issued for Audit and Extra Credit courses.**
**** Grace Mark awarded.**

Entered by:

Verified by:

Controller of Examinations **Principal**

Reverse side of the Mark cum Grade Card (COMMON FOR ALL SEMESTERS)

Description of the Evaluation Process

Grade and Grade Point

The evaluation of each course comprises of internal and external components in the ratio 1:3 for all Courses. Grades and Grade Points are given on a seven (7) point scale based on the percentage of Total Marks (ISA + ESA) as given in Table 1. Decimals are corrected 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
45 to below 55	C	Satisfactory	5
40 to below 45	D	Pass	4
Below 40	F	Failure	0

Table 1

Credit Point and Grade Point Average

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

Grade Point Average of a Semester (SGPA) or Cumulative Grade Point Average (CGPA) for a Programme is calculated using the formula

SGPA or CGPA = TCP/TC

where TCP is the Total Credit Point for the semester/programme and TC is the Total Credit for the semester/programme

GPA shall be rounded off to two decimal places.

The percentage of marks is calculated using the formula;

$$\text{\% Marks} = \left(\frac{\text{total marks obtained}}{\text{maximum marks}}\right) \times 100$$

Weighted Average Score (WAS) is 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.

Grades for the different Semesters and overall Programme are given based on the corresponding GPA, as shown in Table 2.

GPA	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
4.5 to below 5.5	C	Satisfactory
4 to below 4.5	D	Pass
Below 4	F	Failure

Table 2

Note: Course title followed by (P) stands for practical course. A separate minimum of 40% marks each for internal and external assessments (for both theory and practical) and an aggregate minimum of 40% marks is required for a pass in each course. For a pass in a programme, a separate minimum of Grade D for all the individual courses and an overall Grade D or above are mandatory. If a candidate secures Grade F for any one of the courses offered in a Semester/Programme, only Grade F will be awarded for that Semester/Programme until the candidate improves this to Grade D or above within the permitted period.

PROGRAMME STRUCTURE

	Course Code	Course Title	Hours /Week	Total Hours	Credit	ISA	ESA	Total
Semester I	BMPH101	Mathematical Methods in Physics - I	4	72	4	25	75	100
	BMPH102	Classical Mechanics	4	72	4	25	75	100
	BMPH103	Electrodynamics, Special Theory of Relativity and Antennas	4	72	4	25	75	100
	BMPH104	Electronics	4	72	4	25	75	100
		General Physics Practical (P)	9	162	Evaluation in Semester II			
		Total	**25**	**450**	**16**	**100**	**300**	**400**
Semester II	BMPH205	Mathematical Methods in Physics - II	4	72	4	25	75	100
	BMPH206	Quantum Mechanics – I	4	72	4	25	75	100
	BMPH207	Thermodynamics and Statistical Mechanics	4	72	4	25	75	100
	BMPH208	Condensed Matter Physics	4	72	4	25	75	100
	BMPH2P01	General Physics Practical (P)	-	-	3	25	75	100
	BMPH2P02	Electronics Practical (P)	9	162	3	25	75	100
		Total	**25**	**450**	**22**	**150**	**450**	**600**
Semester III	BMPH309	Quantum Mechanics – II	4	72	4	25	75	100
	BMPH310	Computational Physics	4	72	4	25	75	100
	BMPH311	Digital Signal Processing	4	72	4	25	75	100
	BMPH312	Microprocessors and Semiconductor Devices	4	72	4	25	75	100
		Computational Physics Practical (P)	9	162	Evaluation in Semester IV			
		Total	**25**	**450**	**16**	**100**	**300**	**400**
Semester IV	BMPH413	Atomic and Molecular Physics	4	72	4	25	75	100
	BMPH414	Nuclear and Particle Physics	4	72	4	25	75	100
	BMPH415	Instrumentation and Communication Electronics	4	72	4	25	75	100
		Elective Course	4	72	4	25	75	100
	BMPH4P03	Computational Physics Practical (P)	-	-	3	25	75	100
	BMPH4P04	Advanced Electronics Practical (P)	9	162	3	25	75	100
	BMPH4PJ	Project	-	-	2	25	75	100
	BMPH4VV	Viva Voce	-	-	2	-	100	100
		Total	**25**	**450**	**26**	**175**	**625**	**800**
		Grand Total			**80**			**2200**

ELECTIVE COURSES

BMPH4E01	Thin Film and Nanoscience
BMPH4E02	Astrophysics and Cosmology
BMPH4E03	Nonlinear Dynamics and Chaos

SEMESTER I

BMPH101: MATHEMATICAL METHODS IN PHYSICS – I

Total Hours: 72

Credit: 4

Course Objective: To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses.

Course Outcome:

- Students will be equipped to probe the models of physical world
- Mathematical structure of the governing laws in physics will be revealed
- They will also have an appreciation of generalized functions, their calculus and applications

Module I Vectors and Vector Spaces (18 Hours)

Integral forms of gradient, divergence and curl – line, surface and volume integrals – Stoke's theorem, Gauss's theorem and Green's theorem – potential theory – scalar, gravitational and centrifugal potentials – Orthogonal curvilinear coordinates – gradient, divergence and curl in Cartesian, spherical and cylindrical co-ordinates – equation of continuity – Laplacian operator, Laplace's equation and application to electrostatic field and wave equations .

Linear vector spaces – Hermitian, unitary and projection operators with their properties – inner product space – Schmidt orthogonalization – Hilbert space – Schwartz inequality.

Module II Matrices (18 Hours)

Symmetric, Hermitian, orthogonal, unitary and normal matrices –Similarity transformation – unitary and orthogonal transformations - eigen values and eigenvectors – Cayley-Hamilton theorem–matrix inversion by Cayley-Hamilton theorem - diagonalisation using normalized eigenvectors – normal modes of vibrations as an example of eigen value problem– Pauli spin matrices –solution of a set of linear equations – matrix inversion method, Gauss elimination method, Gauss-Jordan method – iteration methods for solution of set of linear equations by Gauss-Seidel method and Jacobi method.

Module III Partial Differential Equations (18 Hours)

Linear differential equations with constant coefficients- methods for finding complementary function- general method of finding the particular integral of any function

Characteristics and boundary conditions for partial differential equations– separation of variables -Helmholtz equation (Cartesian, Spherical polar and Cylindrical coordinates)- heat equation -self-adjoint ODEs - Hermitian operators and their properties – Schmidt orthogonalization –non-homogeneous equations – Green's function - 1-dimensional Green's function eigenvalue equation of Green's function and Dirac delta function.

Module IV Special Functions and Differential Equations (18 Hours)

Gamma and beta functions – different forms of beta and gamma functions – evaluation of standard integrals – Dirac delta function – Kronecker delta, properties and applications.

Series solution of linear second order differential equations – Frobenius method

Bessel's differential equation – Bessel functions – Legendre differential equation – Hermite differential equation – Laguerre differential equation – (Generating function, recurrence relations, and orthogonality condition for all functions) – Rodrigue's formula.

Reference

1. Mathematical Methods for Physicists, G.B. Arfken & H.J. Weber 4th Edition, Academic Press
2. Mathematical Physics, H.K Dass & R. Verma, S.Chand & Co.
3. Mathematical Physics, B.D. Gupta, Vikas Pub.House, New Delhi
4. Mathematical Physics, Sathyaprakash, Sultan Chand & Sons, New Delhi.
5. Mathematical Physics, B.S. Rajput, Y Prakash 9th Ed, Pragati Prakashan
6. Mathematical methods in Classical and Quantum Physics, T. Dass & S. K. Sharma, Universities Press (2009)
7. Advanced Engineering Mathematics, E. Kreyszig, 7th Ed., John Wiley
8. Introduction to Mathematical Methods in Physics, G.Fletcher, Tata McGraw Hill
9. Advanced Engineering Mathematics, C.R. Wylie, & L C Barrett, Tata McGraw Hill
10. Advanced Mathematics for Engineering and Physics, L.A. Pipes & L.R. Harvill, Tata McGraw Hill
11. Mathematical Methods in Physics, J. Mathew & R.L. Walker, India Book House.

BMPH102: CLASSICAL MECHANICS

Total Hours: 72

Credit: 4

Course Objective: 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.

Course Outcome:

- Students will be able to design the mathematical models of the physical systems.
- The analytical problem solving skills will be extended to a general frame work.
- Understanding of advanced level mathematical and geometrical structure of classical mechanics is implied.
- The capability of handling linear systems will be extended to solve nonlinear systems.

Module I Lagrangian Formulation and Central Force Problem (16 Hours)

Newtonian Mechanics: a review-Generalised coordinates, velocities, forces - Variational principle –Euler Lagrange equations from Calculus of variations –Deduction of Lagrange's equations from Euler –Lagranges equation. Applications of Lagrange's equation- Symmetry properties of space and time.

Inverse square law of force- Central force and motion in a plane - equivalent one dimensional problem – Equation of motion under central force and first integrals- the differential equation for orbits – Deduction of Keplers first law and classification of orbits –Deduction of Keplers third law

Module II Small Oscillations and Rigid Body Rotations (20 Hours)

Small oscillations –Potential energy and equilibrium-Stable ,unstable and neutral equilibrium General theory of small oscillations –Secular equations and eigen value equations -Two coupled oscillators- normal coordinates and normal modes - linear triatomic molecules. Generalised co-ordinates of a rigid body. - Euler angles. - Angular momentum and Inertia tensor-Principal axes –principal moments of inertia-Rotational kinetic energy- Euler equations of motion for a rigid body- torque free motion of a rigid body. Rate of change of a vector - Centrifugal force- Coriolis force.

Module III Hamiltonian Dynamics and Phase Plane Analysis (16 Hours)

Cyclic coordinates and generalised momentum- Hamiltonian function and conservation of energy. Modified Hamilton's principle –Hamilton's equations from variational principle.

Phase plane analysis: Linear systems – Linear stability analysis: The stability matrix – Classification of fixed points – A few examples of fixed point analysis – phase curve of simple harmonic oscillator and damped oscillator – phase portrait of the pendulum.

Module IV Canonical Transformation and Hamilton Jacobi Theory (20 Hours)

Transformation of phase space – formulation – different cases – generating function – examples – harmonic oscillator – conditions for canonical transformation. Poisson Brackets – properties – equations of motion in Poisson bracket form – angular momentum Poisson brackets – infitesimal canonical transformation.

Hamilton-Jacobi equation – free fall under gravity – harmonic oscillator problem - Hamilton's principal function and characteristic function- physical significance with harmonic oscillator as example. Action and Angle variables in systems of one degree of freedom-Harmonic oscillator. Hamilton-Jacobi equation as the short wavelength limit of Schrodinger equation.

Reference

1. J C Upadhyay, Classical Mechanics, Himalaya Publishing House
2. Steven H Strogatz, Nonlinear dynamics and chaos, CRC Press, Taylor & Francis Group.
3. G. Aruldhas, Classical Mechanics, Prentice Hall 2009
4. H. Goldstein, C. Poole and J. Safko , Classical Mechanics (Third Edition) , Pearson.
5. S.T. Thronton and J.B.Marion, Classical Mechanics of Particles and Systems., 5th Edition, Brools and Cole Publishing o.
6. Michael Tabor, Chaos and Integrability in Nonlinear Dynamics. , Wieley - Blackwell
7. V.B. Bhatia , Classical Mechanics , Narosa Publishing
8. L. D. Landau and E. M. Lifshitz, Mechanics, Vol. 1 of course of Theoretical Physics, Pergamon Press, 2000.

BMPH103: ELECTRODYNAMICS, SPECIAL THEORY OF RELATIVITY AND ANTENNAS

Total Hours: 72

Credit: 4

Course Objective: To evaluate fields and forces in Electrodynamics and Magneto dynamics using basic scientific method. To provide concepts of relativistic electrodynamics and its applications in branches of Physical Sciences.

Course Outcome:

Students will learn to,

- Apply Maxwell’s equations to a variety of problems involving timedependent 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.
- Analyze the radiation mechanisms of antennas
- Demonstrate knowledge of antennas in communication systems.
- Ability to discriminate between antennas on the basis of their electrical performance.

Module I Electrostatics and Electromagnetic Waves (18 Hours)

Electrostatics-The electric field-Divergence and curl of electrostatic fields –electric potential Poisson’s Equation and Laplaces’s equation-Electrostatic boundary conditions-Work and energy in electrostatics. Magnetostatics-Lorentz force law-The Biot- Savart law-The divergence and curl of B-Comparison of Magnetostatics and electrostatics-Magnetic vector potential

Electrodynamics-Electromotive force-electromagnetic induction-energy in magnetic fields-Maxwell’s equations-electrodynamics before Maxwell’s equations-magnetic charge-Potential formulation- Gauge transformations-Maxwell’s equations in Matter-boundary conditions-Conservation laws-Charge and energy-Continuity equation- Pointing’s theorem-Conservation of Momentum-Maxwell’s stress tensor-Angular momentum

The electromagnetic Waves in Vacuum-Electromagnetic waves in Matter-Reflection and transmission at Normal Incidence- Reflection and transmission at oblique Incidence-

Absorption of electromagnetic waves in conductors-reflection at a conducting surface-Dispersion –frequency dependence of permittivity-Deduction of Cauchy's formula.

Module II Special Theory of Relativity and Relativistic Electrodynamics (18 Hours)

Matrix representation of Lorentz transformation – Minkowski space – structure of spacetime– Four vectors – Addition of velocities – Four velocity – Relativistic momentum and energy – Dynamics of relativistic particles – Lagrangian and Hamiltonian of relativistic charged particle – motion in a uniform static electric and magnetic fields. Minkowski forces, Magnetism as a relativistic phenomenon, Transformation of the field, Electromagnetic field tensor, Electrodynamics in tensor notation, Potential formulation of relativistic electrodynamics.

Module III Electromagnetic Radiation (18 Hours)

Retarded potentials, Electric dipole radiation, Magnetic dipole radiation, Jefimenkos equations, Point charges, Lienard-Wiechert potential, Fields of a moving point charge, Power radiated by point charge-Larmour formula. Bremsstrahlung. Radiation reaction and its physical basis The Abraham-Lorentz formula

Module IV Antenna, Wave Guides and Transmission Lines (18 Hours)

Radiation resistance of a short dipole, Radiation from a quarter wave monopole or a half wave dipole. Antenna parameters – radiation pattern, beam width, radiation power density, directivity, polarisation, antenna efficiency and gain. Waves between parallel conducting planes -TE, TM and TEM waves. TE and TM waves in rectangular wave guides, Impossibility of TEM waves in rectangular wave guides. Transmission Lines-Principles-Characteristic impedance, standing waves-quarter and half wavelength lines

Reference

1. Introduction to Electrodynamics-David J Griffiths, PHI
2. Antenna and wave guide propagation - K. D Prasad – Satyaprakashan
3. Electromagnetic waves and radiating systems, E.C. Jordan & K.G. Balmain PHI, 1968
4. Electronic Communication Systems (5th edition) – George Kendy et.al – TMH
5. Antennas, J.D Kraus, Tata Mc-Graw Hill.
6. Classical Electrodynamics, J. D. Jackson, Wiley Eastern Ltd.
7. Electromagnetic fields, S. Sivanagaraju, C. Srinivasa Rao, New Age International.
8. Introduction to Classical electrodynamics, Y. K. Lim, World Scientific, 1986.
9. Electromagnetic Waves and Fields, V.V. Sarwate, Wiley Eastern Ltd, New Age International

BMPH104: ELECTRONICS

Total Hours: 72

Credit: 4

Course Objective: To develop an understanding of fundamentals of electronics in order to deepen the understanding of electronic devices that are part of the technologies that surround us.

Course Outcome:

The students will be able to:

- Develop competence in Combinational Logic Problem formulation and Logic Optimisation
- Develop design capability in the field of combinational logic using
- Develop competence in analysis of synchronous and asynchronous sequential circuits
- Develop design capability in synchronous and asynchronous sequential circuit
- Acquire knowledge on the fundamentals of analog integrated circuit
- Develop competence in linear and nonlinear Opamp circuit analysis
- Acquire knowledge on commonly used linear and non-linear applications of Opamps and Comparators
- Develop design competence in linear and non-linear Opamp Circuits
- Develop analysis and design competence on signal filtering and signal conversion

Module I Electronic Instrumentation (18 Hours)

Electronic measurements and instruments- voltmeters- ammeters- Ohmeters- multimeters- components of a CRO- CRO classification- dual beam- dual trace - digital storage.

Field Effect Transistor and photonic devices**:** Frequency response of an amplifier circuits, power and voltage gain-impedance matching, Biasing of FET, FET devices - structure, characteristics, FET applications, frequency analysis of BJT and FET amplifier stages, Junction field effect Transistor, enhancement type MOSFET's, depletion type MOSFET's, Photodetectors - photoconductor (Light dependent resistor- LDR) and photodiode, p-n junction solar cells - short circuit current, fill factor and efficiency.

Module II Signals and Amplifiers (4 Hours)

Signals-frequency spectrum of signals-analog and digitals signals-amplifiers-circuit models for amplifiers-frequency response of amplifiers.

Operational Amplifiers (14 Hours)

The Ideal Op Amp- The Inverting Configuration- The Noninverting Configuration(using the idea of virtual ground concept) -Difference Amplifiers-instrumentation amplifiers- Integrators and Differentiators -DC Imperfections -Effect of Finite Open-Loop Gain and Bandwidth on Circuit Performance Large-Signal Operation of Op Amps . Influence of negative feedback in Op Amp. Characteristics –gain-input resistance -output resistance-band width-Voltage series feedback and voltage shunt feedback. Active filters-first order and second order low pass Butterworth filter, first and second order high pass filter Butterworth filter, wide and narrow band pass filter, wide and narrow band reject filter, all pass filter.

Module III OPAMP Applications (18 Hours)

Differential amplifier with one op-amp and two op-amps, DC and AC amplifiers, Current to voltage converter- Inverter, Peaking amplifier, scale changer, summer, V to I converter, Analog integration and differentiation, Instrumentation amplifier using transducer bridge, Electronic analog computation, Voltage to current converter with grounded load, Current to voltage converter , Very high input impedance circuit

Comparators, Oscillators and Converters: Basic comparator, Zero crossing detector, voltage limiters, OPAMP based astable and monostable multivibrators, Schmidt trigger, Oscillators: Phase shift and Wien-bridge oscillators – Square wave generator—triangular wave generator—saw tooth wave generator - Voltage controlled oscillator, Voltage to frequency and frequency to voltage converters - Peak detector – Sample and Hold circuit. Phase Locked Loop circuits (PLL), IC555 Internal architecture, Applications, Voltage regulator ICs 78XX and 79XX

Module IV Sequential Digital Circuits (18 Hours)

Flip flops, clocked SR flip flops, JK and MSJK flip-flops, Gated latches, Edge triggered Flip Flops, Flip Flop operating characteristics, Maser Slave Flip flops, different types of registers, Buffer register, serial in serial out, serial in parallel out, parallel in serial out, parallel in parallel out shift registers, shift registers and applications, Synchronous and asynchronous counters, mod-8 ripple counter, decade counters, digital clock, applications of electronic counters.

Digital to Analog converters– Weighted resistor type, R-2R ladder type. ADC—counter method—Successive approximation type- dual slope integrator, Multiplexers—applications of multiplexers.

Reference

1. Microelectronic Circuits; Theory and Applications, Sedra and Smith, Oxford, 6th Edition.
2. Ramakant A Gayakwad, Operational Amplifiers and Linear integrated Circuits, Prentice Hall of India (2000) 4th Edition
3. Electronic Devices and Circuit Teory, Robert L Boylstead & L. Nashelsky – Pearson Education (Fifth Edition)
4. Electronic Devices (Electron Flow Version), 9/E Thomas L. Floyd, Pearson
5. Fundamentals of Electronic Devices and Circuits 5th Ed. David A. Bell, Cambridge.
6. Electronic Communications Dennis Roddy and John Coolen, 4th Ed. Pearson.
7. Modern Digital and Analog Communication systems, B.P. Lathi & Zhi Ding 4th Ed., Oxford University Press.
8. Linear Integrated Circuits and Op Amps, S Bali, TMH
9. D. Roychoudhuri : "Linear Integrated circuits" – New Age International Publishers
10. M.S. Tyagi ; "Introduction to Semiconductor Devices" (Wiley)
11. J. Millman, C, Halkias and C. D. Parikh, Integrated Electronics, Tata Mc Graw Hill (2010)
12. Gupta and Kumar : "Handbook of Electronics"
13. B.G. Streetman, S.K. Banerjee, *Solid state electronic devices*. Pearson Inc (2010)
14. Fundamentals of Digital Circuits—A. Anand Kumar(PHI)

A. Malvino and D.J. Bates, *Electronics Prinicples*,7thEdition,Tata McGraw Hill(2007)

15. D.P .Leach, A.P. Malvino, and G. Saha ,*Digital Principles and Applications*, Tata Mc Graw Hill (2011)
16. G. Keiser, *Optical Fibre Communication*,3rdedition,McGraw Pub (2000)
17. Lal Kishore, *Electronic measurements and Instrumentation*, Dorling Kindersley (India) Pvt Ltd(2010)
18. Joachion Piprek, Semiconductor Optoelectronic Devices, Academic Press (2003)
19. T.F. Bogart Jr, J. S. Beasley and G. Reid, Electronic devices and circuits, Sixth Edition, Pearson Inc (2004)
20. W.D. Cooper, A, O, Helfrik and H. Albert, Electronic Instrumentation and measurement Techniques, PHI (1997).
21. Video by Prof. D.C. Dube IIT Delhi http://nptel.iitm.ac.in/courses/115102014
22. Video by Prof. Amitava Dasgupta IIT Madras, http://nptel.iitm.ac.in/video.php?subjectId=108106069

SEMESTER II

BMPH205: MATHEMATICAL METHODS IN PHYSICS – II

Total Hours: 72

Credit: 4

Course Objective: The laws of physics are often expressed through the relatively complex mathematical apparatus. This course is intended to give mathematical tools necessary for better understanding of the later courses in physics such as classical electrodynamics, quantum mechanics, solid state physics and statistical physics.

Course Outcome:

- Students will be able to Use Cauchy's integral theorem in Complex integration. Also know how to find Laurent series about isolated singularities and determine residues.
- Understand the nature of the Fourier series and how derivation of a Fourier series can be simplified.
- 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.
- Knowledge about construction of group, its properties and uses of group theory in Physical problems.

Module I Complex Analysis (18 Hours)

Complex variable-Functions of complex variable-Analytic function-Cauchy-Riemann equation-C-R equation in polar form-Harmonic function-Method to find conjugate function-Milne Thomson method to construct an analytic function- Cauchy integral formula- Cauchy integral formula for the derivative of an analytic function-Taylor's and Laurent's series-Zero of an analytic function-poles and residues –Method of finding residue- residue theorem – Evaluation of integrals

Module II Integral Transforms (18 Hours)

Fourier transform - integral form – properties of Fourier transform – convolution - Parseval's identity- Fourier transform of derivatives-Relationship between Fourier transform and Laplace transform- Fourier transform of harmonic oscillator, full wave rectifier– Laplace transform– Properties of Laplace transform-Laplace transformation of unit step function and

Periodic functions- convolution theorem -Evaluation of integrals- inverse Laplace transform – properties and applications – Solution of differential equations-LCR circuit

Module III Differential Geometry (18 Hours)

Definition of tensors – basic properties of tensors – Covariant, contra variant and mixed tensors – Tensor algebra - Levi-Civita tensor, Metric tensor and its properties – Christoffel symbols and their transformation laws – covariant differentiation – geodesic equation – Riemann-Christoffel tensor, Ricci tensor and Ricci scalar.

Module IV Group Theory (18 Hours)

Groups – group of transformations – multiplication table – conjugate elements and classes, subgroups – direct product groups – isomorphism and homomorphism – permutation groups – reducible and irreducible representation – Unitary representations – Schur's lemmas – orthogonality theorem and interpretations – character of a representation – character tables and examples C2V, C3V, C4V – continuous groups – full rotation groups – rotation of functions and angular momentum – Lie groups and lie algebra – SU(2)-SO(3) homomorphism – irreducible representation of SU(2) group – SU(3) group.

Reference

1. Mathematical Methods for Physicists, G.B. Arfken &H.J. Weber 4th Edition, Academic Press.
2. Mathematical Physics, H.K Dass & R. Verma, S.Chand & Co.
3. Mathematical Physics, B.D. Gupta, Vikas Pub.House, New Delhi
4. Mathematical Physics, B.S. Rajput, Y Prakash 9th Ed, Pragati Prakashan
5. Mathematical Methods in Classical and Quantum Physics, T. Dass & S.K. Sharma, Universities Press (2009)
6. Elements of Group Theory for Physicists, A.W. Joshy, New Age India.
7. Mathematical Physics, Sathyaprakash, Sultan Chand & Sons, New Delhi.
8. Group theory- Schaum's series, Benjamin Baumslag & Bruce Chandler, MGH.
9. Tensor Calculus: Theory and problems, A. N. Srivastava, Universities Press.
10. A Students Guide to Vectors and Tensors, Daniel A. Fleisch, Cambridge university press.
11. Schaum's outline of tensor calculus, David C. Kay, MGH.

BMPH206: QUANTUM MECHANICS - I

Total Hours: 72

Credit: 4

Course Objective: To provide an understanding of the formalism and language of non-relativistic quantum mechanics. To understand the concepts of time-independent perturbation theory and their applications to physical situations.

Course Outcome

The students will be able to:

- Have a deep understanding of the mathematical foundations of quantum mechanics
- Ability to solve the Schrodinger equation for simple configurations.
- Understand the effect of symmetries in quantum mechanics.
- Be able to solve the Schrodinger equation using various approximation methods.
- Spin, angular momentum states, angular momentum addition rules, and identical particles

Module I Fundamental Concepts (18 Hours)

Stern-Gerlach experiment and results, Kets, Bras and Operators, Ket space, Bra space and inner products, operators, Base Kets and Matrix representation, Measurements, Observables Compatible observables. Incompatible observables. The fundamental postulates. The Uncertainty principle, The general uncertainty relationship, the minimum uncertainty product, time energy uncertainty relationship. Change of Basis, Unitary equivalent Observables, Position, Momentum and Translation, continuous spectra, position eigen kets and position measurements, translation, momentum as a generator of translation. The Canonical Commutation relations, Wave functions in position and momentum space, Gaussian wave packet.

Module II Quantum Dynamics (18 Hours)

Time evolution operator, properties and Schrodinger equation, Schrodinger picture, Heisenberg picture, interaction picture, Heisenberg equations of motion, simple harmonic oscillator – Heisenberg picture, Hydrogen atom –polynomial method.

Symmetry and conservation laws - Symmetry transformations-space translation and conservation of angular momentum - time translation and conservation of energy-rotation in space and conservation of angular momentum-space inversion-time reversal

Identical particles - Identity of particles, spin and statistics, Pauli's exclusion principle.

Module III Angular momentum (18 Hours)

Rotations and Angular momentum commutation relations - infinitesimal rotations in quantum mechanics-fundamental commutation relations of angular momentum - rotation operator for spin ½ system - Pauli two component formalism - Pauli spin matrices - 2x2 matrix representation of rotation operator – commutation relations for J^2, J_z – eigenvalues of J^2 and J_z - matrix elements of angular momentum operators - representation of the rotation operator – rotation matrix-properties of the rotation matrix - orbital angular momentum as a rotation generator –spherical harmonics- addition of angular momentum and spin angular momentum - addition of spin angular momenta and Clebsch-Gordon coefficients for two spin ½ particles.

Module IV Approximation Methods (18 Hours)

Time independent perturbation theory - non degenerate case and degenerate case with examples of anharmonic oscillator, Stark effect, Hydrogen like atoms-fine structure and Zeeman effect.

Variational method- the variational equation, ground states and excited states, application to ground state of Hydrogen atom and Helium atom.

WKB approximation- wave function-validity –connection formulae- applications - bound states, barrier penetration.

Reference

1. Modern Quantum Mechanics, J.J. Sakurai, Pearson Education.
2. Quantum Mechanics, V. K. Thankappan, New Age International.
3. Quantum Mechanics, Concepts and Applications, N. Zettily, John Wiley & Sons.
4. Quantum Mechanics, G Aruldhas, PHI
5. A Modern Approach to Quantum Mechanics, John S. Townsend, Viva Books MGH
6. Field Quantization, W Greener, J Reihardt, Springer
7. Relativistic Quantum Mechanics, J D Bjorken and S Drell, MGH
8. Quantum Field Theory, Lewis H Ryder, Academic Publishers
9. Introduction to Quantum Field Theory, S J Chang, World Scientific.
10. Quantum Field Theory, Franz Mandl and Graham Shaw, Wiley
11. Basic Quantum Mechanics, A. Ghatak, Macmillan India.
12. Quantum Mechanics, Theory and Applications, Ajoy Ghatak and S Lokhnathan 5th Edition, MacMillan India.
13. Quantum Mechanics B H Bransden and C J Joachain, Pearson Education
14. Principle of Quantum Mechanics, R Shankar, Springer
15. Quantum Mechanics, an Introduction, W Greiner, Springer Verlag

16. Quantum Mechanics, E. Merzbacher, John Wiley
17. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson.
18. Quantum Mechanics, L.I. Schiff, Tata McGraw Hill.
19. Quantum Physic Stephen Gasiorowics, John Wiley & Sons.

BMPH207: THERMODYNAMICS AND STATISTICAL MECHANICS

Total Hours: 72

Credit: 4

Course Objective: To have an appreciation for the modern aspects of equilibrium and non-equilibrium statistical physics. To describe the features and examples of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.

Course Outcome: This course will prepare the student to tackle

- Advanced topics in quantum statistical mechanics through understanding of basic statistical concepts
- Apply them in various applications in other fields such as solid state physics.

Module I Thermodynamics and Probability Theory (18 Hours)

Internal energy-enthalpy-definition of entropy-measurement of entropy- Laws of thermodynamics and their consequences-thermodynamic potentials-Maxwell's relations-chemical potential-phase equillibria. Ideas of probability-classical probability-statistical probability-axioms of probability theory-independent events-concepts of arrangements, permutations and combinations-statistics and distributions-binomial, Poisson, Gaussian distributions. Fluctuations- mean and standard deviation.

Module II Ensemble Description and Partition Function (18 Hours)

Phase space-macroscopic and microscopic states. Statistical ensemble. Partition function-microcanonical, canonical and grand canonical ensembles and partition functions. Free energy and its connection with thermodynamic quantities. Ideal Bose and Fermi gases. Bose-Einstein condensation.

Module III Applications of Statistical Thermodynamics (18 Hours)

The probability that a particle is in a quantum state- density of states in k space-Single particle density of states in energy-distribution of speeds of particles in a classical gas (using partition function). Free energy (from partition function)- Einstein's model of vibrations in a solid (using free energy), Paramagnetism- general calculation of magnetization (using partition function).

Module IV Statistical theory of Magnetism and Irreversible Processes (18 Hours)

First and second order phase transitions- Clausius-Clapeyron equation. One-dimensional Ising model (transfer matrix method), Ising Model- Brag Williams approximation.

Thermodynamic Fluctuations-Brownian motion and Random walk-Diffusion equation-Einstein relation for mobility.

Reference

1. Introduction to Statistical Mechanics, S K Sinha, Narosa
2. Fundamentals of Statistical Mechnaics, New Age, B B Laud
3. Statistical mechanics and properties of matter Ellis Horwood Ltd, E S R Gopal
4. Introductory Statistical Mechanics, Oxford Science Publications, Robert Bowley
5. Statistical Mechanics—R K Pathria and Paul D Beale
6. Statistical Mechanics, John Wiley & Sons - K. Huang
7. Statistical Mechanics, New Age Publishers, B K Agarwal and Melvin Eisner
8. Fundamentals of Statistical and Thermal Physics, Levant books - F Reif
9. Statistical Physics, Pergamon Press, Landau and Lifshitz
10. Thermodynamics and Statistical Mechanics, Springer, Greiner

BMPH208: CONDENSED MATTER PHYSICS

Total Hours: 72

Credit: 4

Course Objective: To provide extended knowledge of principles and techniques of solid state physics. To provide an understanding of structure, thermal and electrical properties of matter.

Course Outcome:

After finishing the course the student should be able to;

- relate crystal structure and degree of ordering to atom binding and packing
- classify condensed matter upon its degree of order, with emphasis on scattering experiments
- explain the thermal properties in solids in particular heat capacity
- classify condensed matter upon its electrical and transport and magnetic properties
- apply the obtained concepts to challenges in condensed matter physics.

Module I Elements of Crystal Structure & Free Electron Theory of Metals (18 Hours)

X-ray diffraction- Braggs equation, Laue's equation and their equivalence, Ewald construction, reciprocal lattice, reciprocal lattice to SC, BCC, and FCC- properties of reciprocal lattice, X-ray diffraction method by rotation / oscillation method)

Free Electron Theory of Metals: Electrons moving in a three dimensional potential well - density of states - Fermi-Dirac statistics - Electronic specific heat - electrical conductivity of metals - relaxation time and mean free path - electrical conductivity and Ohm's law - Widemann-Franz-Lorentz law - electrical resistivity of metals- Hall effect-thermionic emission-failure of free electron theory.

Module II Band Theory of Solids (18 Hours)

Bloch theorem - Kronig-Penney model - Brillouin zone construction of Brillouin zone in one and two dimensions – extended, reduced and periodic zone scheme of Brillouin zone - Band theory of semiconductors: Generation and recombination - minority carrier life-time - mobility of current carriers - drift and diffusion - general study of excess carrier movement- diffusion length. Free carrier concentration in semiconductors - Fermi level and carrier concentration in semiconductors - mobility of charge carriers - effect of temperature on mobility - electrical conductivity of semiconductors – Hall effect in semiconductors - junction properties- metal-metal, metal semiconductor and semiconductor-semiconductor junctions.

Module III Lattice Dynamics and Superconductivity (18 Hours)

Vibrations of crystals with diatomic lattice – quantization of elastic waves – phonon momentum. Anharmonicity and thermal expansion - specific heat of a solid – Einstein model - density of states - Debye model – thermal conductivity of solids - thermal conductivity due to electrons and phonons - thermal resistance of solids.

Superconductivity: Thermodynamics and electrodynamics of superconductors- London Equations- flux quantization-single particle tunnelling- Josephson superconductor tunnelling-macroscopic quantum interference-BCS Theory of Superconductivity.

Module IV Magnetic and Dielectric Properties of Solids (18 Hours)

Review of basic terms and relations in magnetism-Classical theory of pararmagnetism-paramagnetic susceptibility of solid substances-Quantum theory of paramagnetism-Ferromagnetism-origin of ferromagnetism-Quantum theory of ferromagnetism-Weiss Molecular field-Curie-Weiss law-spontaneous magnetisation-internal field and exchange interaction-magnetisation curve-saturation magnetisation-domain model

Dielectric properties of solids: Polarisation-dielectrics-Linear Dielectrics- Ferro-electric materials-Dipolar theory of ferroelectric materials-classification of ferroelectric materials-antiferroelectricity-introduction to meta materials.

Reference:

1. Introduction to Solid State Physics, C. Kittel, 3rd Edn. Wiley India.
2. Solid State Physics: Structure and Properties of Materials, M. A.Wahab, Narosa 2nd Edn.
3. Solid State Physics, S.O. Pillai, New Age International 6th Edn.
4. Solid State Physics, N.W. Ashcroft & N.D. Mermin, Cengage
5. Elementary Solid State Physics, M. Ali Omar, Pearson
6. Solid State Physics, A.J. Dekker, Macmillan & Co Ltd. (1967)
7. Introduction to Solids- Azaroff. V –TM
8. Magnetic materials: Fundamentals and applications Nicola A Spaldin Cambridge university Press 2nd edition
9. Metamaterials Transformation optics and cloaks invisibility-John Pendry.
10. Metamaterials Characteristics, Process and Applications, Kaushal Gangwar, Paras and Dr. RPS Ganwar.

SEMESTER I AND II

PRACTICAL

BMPH2P01: GENERAL PHYSICS PRACTICALS

Total Hours: 162

Credit: 3

(Minimum of 12 Experiments with Error analysis of the experiment is to be done)

1. Y, n, σ Cornu's method (a) Elliptical fringes and (b) Hyperbolic fringes.
2. Absorption spectrum –KMnO4 solution / Iodine vapour – telescope and scale arrangement – Hartmann's formula or photographic method
3. Frank and Hertz Experiment – determination of ionization potential.
4. Hall Effect (a) carrier concentration (b) Mobility & (c) Hall coefficient.
5. Resistivity of semiconductor specimen–Four Probe Method.
6. Band gap energy measurement of silicon.
7. Magnetic Susceptibility-Guoy's method / Quincke's method.
8. Michelson Interferometer - λ and dλ / thickness of mica.
9. Ultrasonic-Acousto-optic technique-elastic property of a liquid.
10. B - H Curve-Hysteresis.
11. Oscillating Disc-Viscosity of a liquid.
12. e/m of electron-Thomson's method.
13. Characteristic of a thermistor - Determination of the relevant parameters.
14. Dielectric constant of a non-polar liquid.
15. Dipole moment of an organic molecule (acetone).
16. Young's modulus of steel using the flexural vibrations of a bar.
17. Verification of Stefan's law and determination of Stefan's constant of radiation
18. Temperature dependence of a ceramic capacitor and verification of Curie-Wiess law
19. Experiments using GM counter- absorption co-efficient of beta rays in materials.
20. Multichannel analyzer for alpha energy determination.
21. Zeemann effect setup – measurement of Bohr magnetron
22. Photoelectric effect – determination of Plank's constant using excel or origin.
23. Magneto-optic effect (Faraday effect)- rotation of plane of polarization as a function of magnetic flux density.

24. Linear electro-optic effect (Pockels effect) – half wave voltage and variation of intensity with electric field.
25. Silicon diode as a temperature sensor.
26. Electrical and thermal conductivity of copper and determination of Lorentz number.

[Few more experiments of equal standard can be added.]

BMPH2P02: ELECTRONICS PRACTICALS

Total Hours: 162

Credit: 3

(Minimum of 12 experiments should be done, with not less than 5 from each section)

Section –A

1. R C Coupled CE amplifier - Two stages with feedback – Frequency response and voltage gain.
2. Differential amplifiers using transistors and constant current source -Frequency response, CMRR.
3. Push-pull amplifier using complementary - symmetry transistors power gain and frequency response.
4. R F amplifier - frequency response & band width - Effect of damping.
5. Voltage controlled oscillator using transistors.
6. Voltage controlled oscillator using IC 555
7. R F Oscillator - above 1 MHz frequency measurement.
8. Differential amplifier - using op-amp.
9. Active filters – low pass and high pass-first and second order frequency response and roll off rate.
10. Band pass filter using single op-amp-frequency response and bandwidth.
11. Wein-bridge Oscillator – using op-amp with amplitude stabilization.
12. Op-amp-measurement of parameters such as open loop gain – offset voltage – open loop response.
13. Crystal Oscillator
14. RC phase shift oscillator
15. AM generation and demodulation
16. Solving differential equation using IC 741
17. Solving simultaneous equation using IC 741
18. Current to voltage and voltage to current converter (IC 741)
19. Temperature measurement using ADC and microprocessor.
20. Op-amp-triangular wave generator with specified amplitude.
21. Familiarization of Arduino.
22. Arduino - stepper motor control.
23. Arduino - measurement of analog voltage.
24. Interfacing DAC

25. μp-Digital synthesis of wave form using D/A Converter.

26. Waveguides

Section –B: (Circuit Simulation)

1. Design and simulate a single stage RC coupled amplifier with feedback. Study the frequency response
2. Design and simulate a two stage RC coupled amplifier with feedback. Study the frequency response.
3. Design and simulate an RC phase shift oscillator using BJT and observe the sinusoidal output waveform.
4. Design and simulate the first order and second order low pass Butterworth filter for a cut off frequency of 1KHz. Obtain the frequency response curve and determine the roll off rate.
5. Design and simulate a differential amplifier using transistors with constant current source. Study its frequency response. Also determine its CMRR.
6. Design and simulate a differentiator and integrator using Op-amp. Obtain the output waveform for an input square wave.

[Few more experiments of equal standard can be added.]

SEMESTER III

BMPH309: QUANTUM MECHANICS – II

Total Hours: 72

Credit: 4

Course Objective: This is 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:

After having taken this course the student will have acquired the following skills:

- 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 understand concepts and to perform calculations of scattering of particles.
- The ability to critically understand and evaluate modern research utilizing quantum theory in condensed matter, nuclear and particle physics.

Module I Time Dependent Perturbation Theory (18 Hours)

Time dependent potentials - interaction picture - time evolution operator in interaction picture - time dependent perturbation theory - Dyson series – transition probability- - constant perturbation - Transitions into continuum of final states- Fermi-Golden rule - harmonic perturbation - interaction of atoms with classical radiation field - Induced emission and absorption -Einstein's A and B coefficients –Transition rates within the dipole approximation. The Electric dipole selection rules.

Module II Quantum Theory of Scattering (18 Hours)

Scattering cross section - General considerations - differential and total cross section - the scattering amplitude -Green's functions - formal expression for scattering amplitude.

The Born approximations – The first Born approximations - validity of the born approximations - Yukawa potential - Rutherford scattering. Partial wave analysis - asymptotic behaviour of partial waves - phase shifts - the scattering amplitude in terms of phase shifts - the differential and total cross section - optical theorem – Dependence of phase shifts on potential - potential of finite range - low energy scattering. Resonance scattering. Exactly Soluble Problems - scattering by a square well potential - scattering by a hard sphere.

Module III Relativistic Quantum Mechanics (22 Hours)

Need for relativistic wave equation - Klein-Gordon equation - Probability conservation - covariant notation - derivation of Dirac equation - conserved current representation -large and small components - approximate Hamiltonian for electrostatic problem - free particle at rest - plane wave solutions - gamma matrices - bilinear covariant – relativistic covariance of Dirac equation - angular momentum as constant of motion.

Module IV Quantization of fields (14 Hours)

The principles of canonical quantization of fields, Lagrangian field theory, Classical field equations, Hamiltonian formalism, nonrelativistic fields-system of Fermions-system of Bosons, quantization of Electromagnetic field-Coulomb's gauge

Reference

1. Modern Quantum Mechanics, J.J. Sakurai, Pearson Education.
2. Quantum Mechanics, V. K. Thankappan, New Age International.
3. Quantum Mechanics, Concepts and Applications, N. Zettily, John Wiley & Sons.
4. Quantum Mechanics, G Aruldhas, PHI
5. A Modern Approach to Quantum Mechanics, John S. Townsend, Viva Books MGH
6. Field Quantization, W Greener, J Reihardt, Springer
7. Relativistic Quantum Mechanics, J D Bjorken and S Drell, MGH
8. Quantum Field Theory, Lewis H Ryder, Academic Publishers
9. Introduction to Quantum Field Theory, S J Chang, World Scientific.
10. Quantum Field Theory, Franz Mandl and Graham Shaw, Wiley
11. Basic Quantum Mechanics, A. Ghatak, Macmillan India.
12. Quantum Mechanics, Theory and Applications, Ajoy Ghatak and S Lokhnathan 5^{th} Edition, MacMillan India.
13. Quantum Mechanics B H Bransden and C J Joachain, Pearson Education
14. Principle of Quantum Mechanics, R Shankar, Springer
15. Quantum Mechanics, an Introduction, W Greiner, Springer Verlag
16. Quantum Mechanics, E. Merzbacher, John Wiley
17. Introduction to Quantum Mechanics, D.J. Griffiths, Pearson.
18. Quantum Mechanics, L.I. Schiff, Tata McGraw Hill.
19. Quantum Physic Stephen Gasiorowics, John Wiley & Sons.
20. Quantum Mechanics V. Devanathan , Narosa
21. A Text Book of Quantum Mechanics, P.M. Mathews & K. Venkatesan, TMGH.

BMPH310: COMPUTAIONAL PHYSICS

Total Hours: 72

Credit: 4

Course Objective: The aim is to teach various computational methods such as interpolation, numerical solutions for integration, differentiation, ordinary and partial differential equations. Further, course also aims for imparting knowledge and training in MathLab software.

Course Outcome:

After successfully completed course, student will be able to;

- Apply interpolations, extrapolation and curve fitting
- Numerically solve systems of nonlinear equations.
- Numerically calculate multiple integrals.
- Solve partial and ordinary differential equations
- Solve physical problems using modern computational software.
- Visualize physical problems and their solutions on a computer.
- Use MATLAB programming language.

Module I Curve Fitting and Interpolation (16 Hours)

Principle of least square fitting - least square method for fitting a straight line, parabola, power and exponential curves . Interpolation - Introduction to finite difference operators - separation of symbols. Newton's forward and backward difference interpolation formulae, Lagrange's interpolation formula, Newton's divided difference method. Cubic spline interpolation

Module II Numerical Differentiation and Integration (16 Hours)

Numerical differentiation, errors in numerical differentiation, cubic spline method - finding maxima and minima of a tabulated function - Integration of a function with Trapezoidal Rule, Simpson's 1/3 and 3/8 rule and error associated with each. Romberg's integration, Monte Carlo evaluation of integrals - numerical double integration

Module III Numerical Solution of Differential equations (20 Hours)

Euler method - modified Euler method - Runge-Kutta 4^{th} order method - adaptive step size approach in 4th order R-K method, predictor-corrector methods - Milne's method, Adam-Moulton method.

Elementary ideas and basic concepts in finite difference method - Schmidt Method, Crank-Nicholson method, Weighted average implicit method - concept of stability.

Module IV Introduction to MATLAB (20 Hours)

MATLAB programming: Matrices and vectors, Scripts and functions, Linear Algebra, Curve fitting and interpolation, data analysis, integration and differentiation, Fourier analysis Ordinary differential equations, Graphics

Reference

1. Numerical Methods for Scientists and Engineers-third edition, K. Sankara Rao, PHI Learning private Limited
2. Introductory Methods of Numerical Analysis-fifth edition, S.S. Sastry, PHI Learning private Limited
3. Getting started with MATLAB 7-A quick introduction for scientists and Engineers
4. Mastering MATLAB 7,Duane Hanselma, Bruce Littlefield, Pearson Education
5. Computer oriented numerical methods, V.Rajaraman, PHI Learning private Limited
6. An Introduction to Computational Physics, Tao Pang, CUP
7. Numerical Recipes in C++,W.H. Press, Saul A. Teukolsky, CUP
8. Numerical Methods, Balaguruswami, Tata McGraw Hill, 2009.

BMPH311: DIGITAL SIGNAL PROCESSING

Total Hours: 72

Credit: 4

Course Objective: The primary purpose of the course is a better understanding of the theoretical concepts, and to let the students experience actual DSP happening in real-time, using real devices. After this lecture, the students should be able to understand how to analyze a given signal or system using tools such as Fourier transform and z-transform; what kind of characteristics should we analyze to know the property of a signal or system; how to process signals to make them more useful; and how to design a signal processor (digital filter) for a given problem.

Course Outcome:

This course will prepare the student to

- Understand the elementary mathematical formalism behind digital signal processing
- Apply these concepts in applications.

Module I Basics of Digital Signal Processing (18 Hours)

Signals and representation – classification- continuous time (CT) and discrete time (DT) signals sampling of analog signals- - standard CT and DT signals. Discrete- time linear time-invariant systems-Techniques of analysis of linear systems, Resolution of a discrete time signal into impulses- Response of LTI systems to arbitrary inputs- Properties of convolution and the interconnection of LTI systems- crosscorrelation and autocorrelation. Casual LTI systems Stability of LTI systems- Systems with finite duration and infinite duration impulse response. Discrete- time systems described by difference equations- LTI systems characterized by constant coefficient difference equations.

Module II Frequency Analysis of Signals (18 Hours)

The Fourier series for continuous Time Periodic signals, Power Density Spectrum of Periodic Signals, The Fourier Transform of Continuous -Time Aperiodic Signals, Frequency analysis of DT signals - discrete Fourier Transform – convergence of FT-Gibb's phenomenon, FT Relation to Laplace transform, Z-Transform- regional convergence – rational Z-transform-poles and zeros, Relation of Z-transform to Fourier Transform.

Module III Digital Filters (18 Hours)

LTI systems as Frequency selective filters: Ideal filter characteristics, FIR and IIR Filters – Poles and Zeros of system function - Realization of IIR systems - Direct form I & form II realization. Direct form and cascade form realization of FIR systems - Finite word length effects in digital signal processing. Fast Fourier Transform (FFT) –FFT algorithms- divide and conquer approach- Decimation in time and decimation in frequency algorithm.

Module IV Filter Design Techniques (18 Hours)

System function of IIR and FIR filters, system function and impulse response. IIR filter design techniques - Approximation of derivatives -Impulse invariant method - Bilinear transformation. - FIR filter design techniques - magnitude characteristics of physically realizable filter- Fourier series method - Window techniques - FIR filter using rectangular window.

Reference

1. Digital Signal Processing, John G. Proakis, Dimitris G. Manolakis, PHI
2. Digital Signal Processing: Theory, Analysis and Digital-Filter Design, B. Somanathan Nair, PHI (2004)
3. Digital Signal Processing, P. Ramesh Babu, Scitech
4. Digital Signal Processing, Alan V. Oppenheim & R.W. Schafer, PHI
5. Computer applications in physics, Suresh Chandra, Alpha Science International (2006)
6. Digital Signal Processing, S. Salivahanan, A. Vallavaraj, C. Gnanapriya, TMH
7. Signals and Systems, Allan V. Oppenheim, Alan S. Willsky, S.H. Nawab, PHI
8. Digital Signal Processing, Sanjay Sharma, S.K. Kataria & Sons, 2010

BMPH312: MICROPROCESSORS AND SEMICONDUCTOR DEVICES

Total Hours: 72

Credit: 4

Course Objective: This course is expected to provide knowledge of Micro Processor and Interfacing Devices.

Course Outcome:

- Familiarization of microprocessors and microcontrollers (Intel)
- Apply knowledge about internal architecture and demonstrate programming proficiency using the various addressing modes and data transfer instructions
- Familiarization of peripheral devices and design of interfacing real -word control problems using microcontroller, microprocessor and also using the idea of internet of things (IoT).
- Knowledge about theory involved in the working of semiconductor devices.

Module I Introduction to Microprocessors and Architecture of 8 bit Processor (Intel 8085) (18 Hours)

Intel 8085-archtecture and pins –instruction set(self - study)-De-multiplexing of address/data lines in 8085.Timings in processors: Processor Timing cycles-machine cycles of 8085-Timing diagram-op code fetch machine cycle-memory read /write M/C-I/O read/write cycle of 8085-interrupt acknowledge cycle with RST n Instruction- interrupt acknowledge cycle with call instruction-Bus idle m/c--Timing diagram for one byte/two byte /three byte instructions-Few programming examples related to 8085. semiconductor memory devices-Introduction to types of memory- -ROM and PROM-EPROM(2764)-logic block diagram of a 2764IC and its Pin configuration-Static RAM (6264)-logic block diagram & pin configuration-DRAM and NVRAM

Module II Data Transfer Schemes and Interfacing Peripheral Devices. (18 Hours)

Basics of programmable I/O-Architecture and programming of 8255PPI-Programmable interrupt controller-USART8251-standard I/O and Memory mapped I/O. ADC 0808 -internal architecture and pin diagram –sample and hold IC (LF398). Clock for A/D convertor. Classification of data transfer schemes-programmed data transfer-synchronous –asynchronous transfer –interrupt driven data transfer-single interrupt level –software polling –hardware polling. interfacing typical static RAM-memory capacity. Generation of chip select signals-decoder-memory organisation in a 8 bit microprocessor system-sketches highlighting implementation of 32 KB RAM and 16KB RAM./Address mapping.

Interfacing 8255 with 8085 -Interfacing circuit and control software for interfacing ADC/DAC with 8085

Module III Microcontrollers and programming (18 Hours)

Introduction to microcontrollers-comparison of microprocessors and microcontrollers-Architecture of 8051 microcontroller-Interfacing external memory-Ports structure-counters and timers-interrupt

Assembly level programming-Classifications of instructions –addressing modes-instruction set (self study) -. Introduction to Arduino hardware and interfacing Arduino board to computer- C language basics-familiarization of input/output of Arduino board and standard Arduino library-data storage-programs for LCD interfacing-developing sketches for interfacing various sensors to the boards -Arduino - Interfacing WiFi Serial Module ESP with Arduino -Basics concepts of Internet of Things (IoT) and basics of Iot using Arduino (introduction) -IoT devices-IoT devices and computers-Societal benefits of IoT)

Module IV Semiconductor Devices (18 Hours)

Schottky barrier diode-qualitative characteristics-ideal junction properties-nonlinear effects on barrier height-current voltage relationship-comparison with junction diode-metal semiconductor Ohmic contact-ideal non-rectifying barriers-tunnelling barrier-specific contact resistances - hetero-junctions - hetero junction materials-energy band diagram-two dimensional electron gas –equilibrium electrostatics –current voltage characteristics

Reference

1. Microprocessors and Microcontrollers, A Nagoor Kani, 2nd Ed. TMH, New Delhi
2. Fundamentals of Microprocessor and Microcomputers, B. Ram, Dhanpat Rai Publications
3. Introduction to Microprocessors Aditya P Mathur, 3rd edition, T M H, India
4. The Microcontroller and Embedded systems Using Assembly and C, Muhammad Ali Mazidi, Person,2nd ed.
5. The 8051 microcontroller Kenneth J Ayala
6. Advanced microprocessors and peripherals, Architecture, Programming and Interfacing A K Ray TMH
7. www.ardunio.cc
8. wwwedsim51.com
9. Programming Ardunio, Getting started with Sketches Simon MonkMc Graw Hill, India
10. Ardunio programming Note Book, Written and compiled by Brian W Evans

SEMESTER IV

BMPH413: ATOMIC AND MOLECULAR PHYSICS

Total Hours: 72

Credit: 4

Course Objective: To provide an understanding of the fundamental aspects of atomic and molecular physics. To study the spectroscopy of the multi-electron atoms and diatomic molecules.

Course Outcome

- Understands the nature and behaviour of interactions between matter and energy at both the atomic and molecular level.
- Study the basic principles of the different spectroscopic techniques, methods and the interpretation the spectrum.

Module I Atomic Spectra (18 Hours)

The hydrogen atom and the three quantum numbers *n*, *l* and *ml*. - electron spin - spectroscopic terms. Spin-orbit interaction, derivation of spin-orbit interaction energy, fine structure in sodium atom, selection rules. Lande g-factor, normal and anomalous Zeeman effects, Paschen–Back effect and Stark effect in one electron system. L S and j j coupling schemes (vector diagram) - examples, derivation of interaction energy, Hund's rule, Lande interval rule. Hyperfine structure and width of spectral lines.(qualitative ideas only).

Module II Microwave and Infrared Spectroscopy (18 Hours)

Microwave Spectroscopy- Classification of molecules- Rotational spectra of rigid diatomic molecules - intensity of spectral lines - effect of isotopic substitution. Non–rigid rotor - rotational spectra of non-rigid rotator – Rotational spectra of polyatomic linear and symmetric top molecules – Applications of microwave spectroscopy-Stark effect-Born-Oppenheimer approximation.

IR Spectroscopy-Vibrational energy of a diatomic molecule- harmonic oscillator model-zero point energy-Anharmonic oscillator model- diatomic vibrating rotor – break down of Born-Oppenheimer approximation - vibrations of polyatomic molecules - overtone and combination frequencies - influence of rotation on the spectra of polyatomic linear and symmetric top molecules - analysis by IR technique - Fourier transform IR spectroscopy.

Module III Raman and Electronic Spectroscopy (18 Hours)

Raman Spectroscopy: Pure rotational Raman spectra - linear and symmetric top molecules - vibrational Raman spectra – Raman activity of vibrations - mutual exclusion principle - rotational fine structure - structure determination from Raman and IR spectroscopy. Non-linear Raman effects - hyper Raman effect - stimulated Raman effect - CARS, PARS

Electronic Spectroscopy: Electronic spectra of diatomic molecules - progressions and sequences - intensity of spectral lines. Franck – Condon principle - dissociation energy and dissociation products - Rotational fine structure of electronic-vibrational transition - Fortrat parabola - Predissociation.

Module IV Spin Resonance Spectroscopy (18 Hours)

NMR: Quantum mechanical and classical descriptions - Bloch equations - relaxation processes - chemical shift - CW spectrometer - applications of NMR.

ESR: Theory of ESR (Qualitative) - thermal equilibrium and relaxation - g- factor - hyperfine structure -applications.

Mossbauer spectroscopy: Mossbauer effect - recoilless emission and absorption - hyperfine interactions – chemical isomer shift - magnetic hyperfine and electronic quadrupole interactions - applications.

Reference

1. Introduction of Atomic Spectra, H.E. White, Mc Graw Hill
2. Spectroscopy (Vol. 1, Vol. 2 & 3), B.P. Straughan & S. Walker, John Wiley &Sons, Science paperbacks 1976
3. Raman Spectroscopy, D.A. Long, Mc Graw Hill international, 1977
4. Introduction to Molecular Spectroscopy, G.M. Barrow, Mc Graw Hill
5. Molecular Spectra and Molecular Structure, Vol. 1, 2 & 3. G.Herzberg, Van Nostard, London.
6. Elements of Spectroscopy, Gupta, Kumar & Sharma, Pragathi Prakshan
7. The Infra Red Spectra of Complex Molecules, L.J. Bellamy, Chapman & Hall. Vol. 1 & 2.
8. Laser Spectroscopy techniques and applications, E.R. Menzel, CRC Press, India
9. Fundamentals of molecular spectroscopy, C.N. Banwell, Tata McGraw Hill
10. Molecular structure and spectroscopy, G. Aruldhas, PHI Learning Pvt. Ltd.
11. Lasers and Non-Linear Optics, B.B Laud, Wiley Eastern
12. Mossbauer Spectroscopy – Principles and Applications , Philip Gutlich
13. Introduction to Solid State Physics – C Kittel, Wiley Eastern

BMPH414: NUCLEAR AND PARTICLE PHYSICS

Total Hours: 72

Credit: 4

Course Objective: The students will have an understanding of the structure of the nucleus, radioactive decay, nuclear reactions and the interaction of nuclear radiation with matter; and develop an insight into the building block of matter along with the fundamental interactions of nature.

Course Outcome:

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

- Analyse production and decay reactions for fundamental particles, applying conservation principles to determine the type of reaction taking place and the possible outcomes
- Describe the role of colour in the strong force, and appreciate why going from strong interactions between quarks to nuclear structure is a currently unsolved problem
- Describe the role of spin-orbit coupling in the shell structure of atomic nuclei, and predict the properties of nuclear ground and excited states based on the shell model
- Apply quark mixing models to analyse weak interaction physics such as beta and kaon decay
- Read, understand and explain scholarly journal articles in nuclear and particle physics
- Make relevant measurements of energy and decay spectra using basic experimental facilities and apply Poisson statistics to evaluate the uncertainties in the data.

Module I Nuclear Properties and Nuclear Force (18 Hours)

Nuclear radius, size, shape, mass and abundance of nuclides, binding energy, Semi-empirical mass formula, Nuclear angular momentum and parity, nuclear electromagnetic moments, nuclear excited states, deuteron- ground state, excited state, low energy neutron-proton scattering, scattering length Fermi scattering length, spin dependence of neutron- proton interaction, effective range theory, non central force, proton-proton and neutron-neutron interactions, exchange interaction and saturation of nuclear force, properties of the nuclear force, the exchange force model.

Module II Nuclear Models and Nuclear Decay (18 Hours)

Fermi gas model, Shell model, single particle states in nuclei, applications of shell model : Nuclear spin, nuclear magnetic moments, islands of isomerism, quadruple moments of nuclei, Collective model, vibrations in a permanently deformed nucleus, nuclear rotation, Statistical Models.

Review of alpha decay, Beta decay, Energy release in beta decay, Fermi theory of beta decay, Experimental tests of the Fermi theory, angular momentum and parity selection rules, Comparative half-lives, parity violation in beta decay. Energetics of gamma decay, Multipole radiations, classical electromagnetic radiation, transition to quantum mechanics, angular momentum and parity selection rules, internal conversion.

Module III Nuclear Reactions (18 Hours)

Types of nuclear reactions and conservation laws, energetics of nuclear reactions, isospin, reaction cross sections, Coulomb scattering, nuclear scattering, compound-nucleus reactions, direct reactions, heavy ion reactions.

Fission -Induced fission – fissile materials, Fission chain reactions, Nuclear power reactors, Fusion-Coulomb barrier, stellar fusion, Fusion reactors, Thermo nuclear weapons, Toka- mak reactor, Linear accelerators, Basic idea about LHC and experiments in it.

Module IV Particle Physics (18 Hours)

Basic forces and classification of particles: the four basic forces, the force of gravity, the electromagnetic force, the week force and electroweak theory, the strong force.

The Gell-Mann-Nishijima formula, symmetries and conservation laws , conservation of energy and mass, conservation of linear momentum, conservation of angular momentum, conservation of electric charge, conservation of baryon and lepton numbers, conservation of strangeness, conservation of isospin and its components.

The CPT theorem, conservation of parity, Quark model: The eightfold way, discovery of omega minus, the quark model, the confined quarks, experimental evidences for quark model, coloured quarks, quantum chromodynamics and gluons.

Reference

1. Introductory Nuclear Physics, Kenneth. S. Krane, Wiley, New York, (1987).
2. Nuclear and Particle Physics: An Introduction, Brian R. Martin, Wiley, England, (2006).
3. The particle Hunters, Yuval Ne’eman & Yoram kirsh, CUP, (1996).
4. Introduction to Nuclear Physics, H.A. Enge, Addison Wesley, London, (1975).
5. Nuclear Physics by R.R. Roy and B.P. Nigam, New Age International, New Delhi, (1983).
6. Atomic and Nuclear Physics, Ghoshal,Vol. 2, S. Chand & Company
7. Introduction to Elementary Particle, D.J. Griffiths, Harper and Row, NY,(1987)
8. The Ideas of Particle Physics, An Introduction for Scientists, G D Coughlan, J E Dodd and B M Geipaios, Cabridge University Press, Third Edition

For further reference:

Nuclear Physics: Fundamentals and Applications Video Prof. H.C. Verma IIT Kanpur

http://nptel.iitm.ac.in/courses/

BMPH415: INSTRUMENTATION AND COMMUNICATION ELECTRONICS

Total Hours: 72

Credit: 4

Course Objective: Provide graduates with a strong foundation in mathematics, science and engineering fundamentals to enable them to devise and deliver efficient solutions to challenging problems in Electronics, Communications and allied disciplines.

Course Outcome:

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

- Recognize the evolution and history of units and standards in Measurements.
- Identify the various parameters that are measurable in electronic instrumentation.
- Practice the construction of testing and measuring set up for electronic systems.
- To have a deep understanding about instrumentation concepts which can be applied to Control systems. Relate the usage of various instrumentation standards.
- Various modulation and demodulation techniques of analog communication.
- To analyze different parameters of analog communication techniques.
- It also focuses on pulse modulation and demodulation

Module I Transducers and Digital Instrumentation (18 Hours)

Transducers: Classification of transducers - electrical transducer - resistive transducer - strain gauges- piezo-electric and magnetostrictive transducers - Hall effect transducers – thermistors - inductive transducers - differential output transducers - pressure transducers - pressure cell - photoelectric transducers - photo voltaic cell – semiconductor photo diode – thermo electric transducers – mechanical transducers – ionization transducers – electro chemical transducers. Digital Instrumentation: digital voltmeter – digital multimeter - digital phase meter - digital frequency meter – tachometer - pH meter.

Module II Measurement of Basic Parameters and Recorders (18 Hours)

Transistor Voltmeter - amplified DC meter – A.C voltmeters using rectifiers – precision rectifier – true RMS responding voltmeter – chopper type DC amplifier voltmeter - milli voltmeter using operational amplifier– differential voltmeter – Ohm meter – electronic multimeter – commercial multimeter – output power meters - stroboscope – phase meter – vector impedance meter – Q meter – RF measurement – transistor testers – CRO (Basic ideas) Recorders: Strip chart recorders - XY recorders - digital XY plotters -magnetic recorders - digital data recording - Storage oscilloscope – Digital storage oscilloscope

Module III Introduction to Communication (18 Hours)

AM Techniques – Frequency spectrum, Time domain representation, and power relations in AM, DSBSC, SSB and VSB modulation schemes; Propagation of waves: Ground waves – Field strength at a distance, VLF propagation. Sky waves – The ionosphere and its effects, Reflection mechanism, Virtual height, Critical Frequency, MUF, Skip distance, transmission path and fading. Space wave – Radio horizon. Television Broadcasting – TV systems and Standards. Monochrome transmission – Fundamentals, Beam scanning, Blanking and synchronising pulses. Monochrome reception – Fundamentals, Common, Video and Sound signals. Colour Television – Colour transmission and Colour Reception. Basic ideas of high definition TV – LCD & LED TV, Twisted nematic liquid crystals, constitution of LCD, Active and passive LCD matrices

Module IV Digital Communication (18 Hours)

Pulse Communication -Pulse modulation – PAM – PTM – PCM – PPM. Multiplexing techniques – Frequency division and time division multiplexing. Microwave generators – Tunnel diode, Klystron and Magnetron – Microwaves in communication -Satellite communication. Digital cellular systems GSM, TDMA and CDMA – basic ideas of GPRS, 3G and 4G communication

Reference

1. Electronic Instrumentation, H.S. Kalsi, TMH (1995)
2. Transducers and instrumentation, D.V.S. Murty, PHI (1995)
3. Monochrome and Colour Television R.R. Gulati, New Age India
4. Modern electronic Instrumentation and Measurement Techniques, A.D. Helfric & W.D. Cooper, PHI, (1997)
5. Instrumentation-Devices and Systems 2ndEdn. C.S. Rangan, G.R. Sarma, V.S.V. Mani, TMH, (1998)
6. Electronic Measurements and Instrumentation, M.B. Olive & J.M. Cage, MGH, (1975)
7. Digital Instrumentation, A.J. Bouwens, TMH, (1998)
8. Electronic communication systems, George Kennedy, TMH , 5th Edition.
9. Elements of Electronic Instrumentation. Jha, M. Puri, K.R. Sukesh, & M. Kovar., Narosa, (1996)
10. Instrumentation Measurement and Analysis, B.C. Nakra & K.K. Chaudhry, TMH, (1998)
11. Op-amps and Linear Integrated Circuits, R.A. Gaykward, PHI, (1989)
12. Electronic fundamentals and Applications, John D. Ryder, PHI.

13. Satellite communication, Robert M. Gagliardi, CBS Publishers, Delhi.
14. Electric and electronic measurements and instrumentation 10thEdn. A.K. Sawhney, Dhanpath Rai & Company.

SEMESTER III AND IV

PRACTICAL

BMPH4P03: COMPUTATIONAL PHYSICS PRACTICALS

Total Hours: 162

Credit: 3

[Programs are to be written in C++ language for experiments in section A and Section B. Method, algorithm and flow chart are to be developed. Section C suitable simulation software can be used. A Total of 10 experiments are to be done with a minimum of 3 from each section]

Section – A: (Numerical methods)

1. Write and execute a program for solving a system of linear equations using Gauss elimination method.
2. Write and execute a program to find the root of a non linear equation by bisection method.
3. Write and execute a program for the numerical integration of a function using trapezoidal method.
4. Write and execute a program for the numerical integration of a function using Simpson's 1/3 rule.
5. Write and execute a program to solve the given ordinary differential equation by using Euler method.
6. Write and execute a program to solve the given ordinary differential equation by using Runge-Kutta fourth order method.

Section - B: (Graphics)

1. Write and execute a program to demonstrate the motion of a spherical body in a viscous medium. Study the effect on motion by changing the mass, size of the body and the medium. 2. Write and execute a program for the motion of a projectile in air. Study the motion for different angles of projection.
2. Write and execute a program to find the variation in position, velocity and acceleration of a damped harmonic oscillator. How do the oscillations go from the undamped to the critically damped and to over damped with variation in damping coefficient?

3. Write and execute a program to find the variation in acceleration, velocity, position and energy of a driven oscillator. Plot the position versus time graph for different driving conditions.
4. Write and execute a program to generate a pattern of standing waves. Run this program with different values of amplitude, wavelength and velocity.
5. Write and execute a program to analyze a series LCR circuit with an AC source. Verify the resonance condition.

Section – C: (MATLAB)

1. MATLAB - Matrix operations
2. MATLAB - Solving ordinary differential equations
3. MATLAB - Linear convolution
4. MATLAB - Circular convolution
5. MATLAB - Fourier Transform
6. MATLAB - Random sequence generator
7. MATLAB - Generation of waveforms (sinusoidal, square, triangular, exponential)
8. MATLAB - Curve fitting: fit a straight line/parabola and a polynomial to a given data.

[Few more experiments of equal standard can be added.]

BMPH4P04: ADVANCED ELECTRONICS PRACTICALS

Total Hours: 162

Credit: 3

Minimum 10 experiments should be done choosing at least 2 experiments from each group

(a) Microprocessors and Microcontrollers (use a PC or 8051 microcontroller kit or 8085 microprocessor kit

1. Sorting of numbers in ascending /descending order(8086)
2. Finding the largest and smallest of numbers in array of memory(using 8086)
3. Multichannel analog voltage measurements using ADC card.(8085 kit)
4. Addition of 8 bit/16 bit nos, sorting of numbers(ascending/descending) using microcontroller (kit or software utilities)
5. Generation of square wave of different periods using a microcontroller(ATMEL interfacing card or any other 8051 based cards)

(b) Communication Electronics

1. Generation of PAM and PWM
2. Frequency modulation and demodulation using IC-CD 4046
3. Multiplexer and demultiplexer using IC7432
4. Data transmission and reception through optical fiber link.
5. Bending laws and coupling laws of an optical fiber

(c) Electronic Instrumentation

1. DC and AC milli-voltmeter : Construction and calibration
2. Amplified DC voltmeter using FET
3. Instrumentation amplifier using a transducer.
4. Voltage to frequency and frequency to conversion
5. Construction of digital frequency meter.
6. Construction of digital voltmeter using 8085 microprocessor kit
7. Construction of digital Light intensity recorder using 8085 microprocessor kit.
8. Capacitance measurement using Arduino.
9. Ultrasonic sensor based distance measurement using Arduino.
10. Bluetooth enabled home automation device.

(d) Optoelectronics

1. Characteristics of a photodiode-Determination of the relevant parameters.
2. Beam profile of laser-spot size and divergence
3. Data transmission and reception through optical fiber link.

[Few more experiments of equal standard can be added.]

ELECTIVE COURSES

BMPH4E01: THIN FILMS AND NANOSCIENCE

Total Hours: 72

Credit: 4

Course Objective: The course should give knowledge on mechanisms and processes for synthesis and micro structural evolution of thin films from the vapor phase. Included is also an overview of methods used for synthesis films and industrial applications. Also **s**upport 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. Develop the national capacity to identify, define, and responsibly address concepts and challenges specific to the ethical, legal, and societal implications (ELSI) of nanotechnology.

Course Outcome:

- 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
- Exposure to vacuum science, various pumps, gauges and thin film deposition techniques.
- Fundamental understanding and applications various lithography techniques
- Gain a basic knowledge of near-field optics and exposure to nanophotonics and plasmonics.

Module I Introduction and Experimental Techniques (22 Hours)

Historical evolution of nanoscience and nanotechnology-colour of Lycurgus cup-complexity of integrated circuits- MEMS and NEMS-discovery of graphene and advancement and interest in 2D materials

Band structure and density of states at nanoscale-concept of energy bands and its formation- -idea about conductivity ranges of various materials- donor, accepter states-mobility and formation of excitons and trions in semiconductors.

Density of states in 1D, 2D and 3D-Size and dimensionality effects - potential wells-particle in a 1D and 3D box (review)

Basic idea about microscopy-Resolution of a microscope-Rayleigh criteria, Electron Microscopy- basic principles, operation and applications of scanning electron microscope (SEM), Transmission electron microscope (TEM) and EDX.

Optical Microscopy-basic idea and operation of confocal microscopy-SNOM

Spectroscopy-X-ray photoelectron spectroscopy (XPS) and Ultraviolet photoelectron spectroscopy (UPS) basic principle, operation and applications in determining band structure, valency, basic idea about ESCA.

Scanning Probe microscopy- Basic theory, working of scanning tunneling microscope (STM)- constant height, constant current modes, determination of surface morphology, band structure. Atomic force microscope (AFM)-constant height, constant force modes, determination of surface morphology, young's modulus.

X-ray diffraction-basics and particle size determination

Module II Deposition of Films (18 Hours)

Requirement of Vacuum- derivation of collision rate and mean free-path, various pressure units, high Vacuum to UHV-Pumping speed formula. Vacuum Pumps- Diffusion, Rotary, Turbo-moleuclar, Adsorption and Cryo pump, Measurement of Vacuum-Pirani and Penning (cold- and hot-cathode) gauges Operation of a typical high vacuum and UHV system.Deposition of thin films-Thermal, e-beam, pulsed laser deposition, electron beam and ion beam Sputtering (low-pressure, magnetron and RF), MBE System. Thickness measurement –, quartz crystal thickness monitors, Ellipsometer

Module III Synthesis of Nanomaterials (14 Hours)

Top-down techniques: Lithography-basic idea and processes, photolithography, other optical lithography (EUV, X-Ray, LIL), particle-beam lithographies (e-beam, focused ion beam), probe lithography using STM

Bottom-up techniques: Gas phase methods (Sputter deposition, 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.

Pattern replication techniques: soft lithography, nano imprint lithography. Pattern transfer and enhancement techniques: dry etching, wet etching.

Module IV Nanophotonics, Near Field Interaction and Plasmonics (18 Hours)

Photon absorption – photon emission – photon scattering – metals: permittivity and the free electron plasma – extinction coefficient of metal particle – colours and uses of gold and silver particles. Semiconductors: Tuning the band gap of nanoscale semiconductors –lasers based on quantum confinement. Optical luminescence and fluorescence from direct, bandgap semiconductor nanoparticles - light emission from indirect semiconductors – light-emission from Si nanodots. The limits of light: conventional optics – near filed optics – near-field microscopy — aperture less near-field spectroscopy and microscopy. Optical tweezers.

Plasmonics - merging photonics and electronics at nanoscale dimensions - single photon transistor using surface Plasmon All optical modulation by plasmonic excitation of quantum dots.

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. Vacuumm 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 edd. Plenum press, Newyork, (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).

BMPH4E02: ASTROPHYSICS AND COSMOLOGY

Total Hours: 72

Credit: 4

Course Objective: We expect that after completion of the astrophysics major, students will be inspired to continue and share their interest in astronomical advances and discoveries throughout their lives and 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.

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 I Introduction (18 Hours)

Celestial Sphere: The altitude-Azimuth Coordiate system, Equatorial co-ordiate system; Celestial objects: Planets, Stars, Galaxies, Milkyway; Distance measurements: Parallalax method, Flux, Luminosity, Magnitude system: 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 II Astronomical Instrumentation (16 Hours)

Telescopes: basic optics, Rayleigh Criterion, Seeing, Aberations, Brighness 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 III Stellar and Galaxy Physics (20 Hours)

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 IV Cosmology (18 Hours)

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; Dark matter, Gravitational waves (Basic idea).

Reference

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

7. Stellar Structure and Evolution - Second Edition, Rudolf Kippenhahn, Alfred Weigert, Achim Weiss.
8. Abhyankar K. D. - Astrophysics Stars and Galaxies, Universities Press.
9. Arnab Rai Choudhuri - Astrophysics for Physicists, Cambridge University.
10. Narlikar J. B. - Introduction to Cosmology, Cambridge University Press.

BMPH4E03: NONLINEAR DYNAMICS AND CHAOS

Total Hours: 72

Credit: 4

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.

Course Outcome: On satisfying the requirements of this course;

- 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 analyze 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 I One Dimensional Flows and Bifurcations (18 Hours)

A dynamical view of the world. General introduction to linear and nonlinear equations - Flows on the line: Introduction - Geometric way of thinking - Fixed points and stability - Linear stability analysis - Existence and uniqueness theorem - Impossibility of oscillations: mechanical analogy (over damped systems) - Visualise the dynamics: potentials.

Bifurcations: Introduction - Saddle-node bifurcation - Transcritical bifurcation - Pitchfork bifurcation - Imperfect bifurcations and catastrophes: bead on a tilted wire.

Module II Dynamics in Phase Plane (20 Hours)

Flows on the circle: Introduction - Examples and definitions - Uniform oscillator - Nonuniform oscillator - Overdamped pendulum. - Equivalent circuit and pendulum analog.

Linear Systems: Introduction - Examples and definitions - Classification of linear systems. Dynamical variables - Phase space - Phase trajectories and their properties - Fixed points and linearization - Stability. Stable and unstable manifolds. Lotka-Volterra model of competition - Conservative systems - Reversible systems. Phase plane analysis of pendulum - Cylindrical phase space - Damping effects. Index theory - Global information about the phase portrait.

Module III Nonlinear Oscillations (16 Hours)

Limit cycles: Introduction - Liapunov functions - Poincare-Bendixson theorem - Lienard systems - Relaxation oscillations - Weakly nonlinear oscillators - Perturbation theory - Two timing - Method of averaging.

Saddle-node bifurcation - Transcritical bifurcation - Pitchfork bifurcation - hopf Bifurcation: Supercrittical and Subcrtitical. Coupled oscillators and quasiperiodicity - Poincare Maps.

Module IV Chaotic Systems and Discrete Dynamical Systems (18 Hours)

The Lorenz System: Introduction - Elementary Properties of the Lorenz System - The Lorenz Attractor - A Model for the Lorenz Attractor - The Chaotic Attractor - Exploration: The Rössler Attractor.

Discrete Dynamical Systems - Introduction - 1D maps: Bernoulli, tent and logistic maps. Period-doubling route to chaos. Lyapunov exponents. The Cantor Middle-Thirds Set-Exploration: Cubic Chaos. Elementary ideas on turbulence. Strange attractors.

Reference

1. Nonlinear Dynamics and Chaos – STEVEN H. STROGATZ, Westview Press.
2. Differential Equations, Dynamical Systems and an Introduction to Chaos – MORRIS W. HIRSCH, Elsevier Academic Press.
3. Chaos and Integrability in Nonlinear dynamics – M. TABOR, John Wiley, 1989.
4. Chaos and Nonlinear Dynamics – R.C.HILBORN, Oxford University Press, 1994.

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