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KANNUR UNIVERSITY

Regulation, Scheme and Syllabus

for

M.Sc. PROGRAMME

in

PHYSICS

(Advanced Materials)

Choice Based Credit Semester System

w.e.f 2020 Admission

KANNUR UNIVERSITY

School of Pure and Applied Physics

KANNUR UNIVERSITY

REGULATIONS FOR POST GRADUATE PROGRAMMES UNDER CHOICE BASED CREDIT SEMESTER SYSTEM IN THE DEPARTMENTS/SCHOOLS EFFECTIVE FROM 2020 ADMISSION

1. SCOPE

1.1 These Regulations shall apply to all the Post Graduate programmes, including P.G. Diploma and Certificate Courses conducted by the Departments/Schools of Kannur University

1.2 Choice based Credit Semester System presupposes academic autonomy, cafeteria approach in academic environment, semester system, course credits, alphabetical grading and interdepartmental academic collaboration. There shall be a Department Council consisting of all the Permanent/Contract teachers of the Department. The Head of the Department shall be responsible for admission to all the programmes offered by the Department including conduct of entrance tests, verification of records, admission and evaluation. The Department Council will deliberate on courses and specify the distribution of credits semester wise and course wise. For each course, it will specify the number of credits for lectures, tutorials, practicals etc.

1.3 These regulations shall come into effect from 2020 admission onwards and supersede all other Regulations unless otherwise prescribed.

2. DEFINITIONS

2.1 Curriculum Committee means the Committee constituted by the Vice-Chancellor under these Regulations to monitor the running of Choice based Credit Semester System. One of the Senior Professors shall be the Convener of the Curriculum Committee coordinating the various academic activities

2.2 Department/Centre/School means Department/Centre/School instituted in the University as per Kannur University Statutes.

2.3 '**Academic Programme**' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department.

2.4 '**Course**' means a segment of a Programme limited to one semester in a subject.

2.5 '**Programme Structure**' means a list of courses (Core, Elective, and Open Elective) that makes up an Academic Programme, specifying the syllabus, credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity with University Rules

2.6 '**Core Course**' means a course that a student admitted to a particular programme must successfully complete to receive the degree, and which cannot be substituted by any other course.

2.7 '**Elective Course**' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre.

2.8 '**Open Elective**' means an elective course which is available for students of all programmes, including students of same department. Students of other Departments may opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.

2.9 '**Credit**' means the value assigned to a course which indicates the level of instruction. Normally, one hour lecture per week equals 1 Credit; 2/3 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course

2.10 '**SGPA**' means Semester Grade Point Average calculated for individual semester.

2.11 '**CGPA**' is Cumulative Grade Points Average calculated for all courses completed by the students in the last year of the course by clubbing together SGPA of four semesters

3. ELIGIBILITY FOR ADMISSION

3.1 BSc Physics with Mathematics as complementary course with minimum 50% marks or equivalent grade in core course.

3.2 Candidates who have passed their qualifying examination from Universities outside Kerala and candidates, who have passed their degrees with different nomenclature from the Universities within Kerala, should submit Recognition/Equivalency Certificate while seeking admission.

4. ADMISSION

4.1. As per the regulations prescribed by the University Departments for each Progamme from time to time. However, blind/deaf candidates are not eligible for admission to the course.

4.2 Admission to the PG programme of the University departments shall be made purely on the basis of Entrance Examination. Newspaper notification in this regard has to be made in the month of May itself. Entrance Examination is mandatory for all the departments even if the numbers of applicants are less than the sanctioned strength. If the number of candidates admitted based on the Entrance Exam is less than the sanctioned strength, the concerned department can fill the vacancy by making necessary press release by fulfilling the reservation norms on the basis of the marks obtained in the qualifying examination.

4.3 There should be uniformity in the date of starting the courses and conducting the End Semester Examination of different PG programmes of the University.

5. REGISTRATION

5.1 Every Department/School shall have Permanent / Contract faculty members as Student Advisors. Each student at the time of admission will be assigned to an advisor by the Department Council. He/she will advise the student about the academic Programme and counsel on the choice of courses depending on the student's academic background and objective. The student will then register for the courses she/he plans to take for the semester before the classes begin.

5.2 The Department offering any course shall prescribe the maximum number of students that can be admitted taking into consideration the facilities available. The Department Council will be the authority to fix the optionals that can be offered for a Programme while ensuring that sufficient choice is given to each student in all semesters other than Semester 01. Elective courses for the next semester will be announced within 10 days of the end of the previous semester.

5.3 The student has to complete the prescribed prerequisites for the course before registration. The student within a maximum of 10 working days after the commencement of the classes can change the Optional Course with the consent of Head of the Department in consultation with the Advisor.

5.4 The Department shall make available to all students a bulletin listing all the courses offered in every Semester specifying the Credits, list of topics the course intends to cover, the name of the instructor, the timetable and examination schedule. This will be made available in the last week of each semester after it is approved by the Department Council, the Dean and the Vice Chancellor.

6. COURSE STRUCTURE

6.1 Three kinds of Courses are offered - Core, Elective and Open Elective Courses (including MOOC courses). Core Courses are offered by the Department conducting the Programme. Elective / Open Elective Courses are offered either by the Department conducting the Programme or by any other Department of the University or via MOOC.

6.2 Elective Courses are offered by the Department concerned. Open Elective Courses will be offered by other Departments/Centres/Institutions as options. Open Elective Courses can be opted in any of the Semesters during the entire Programme other than the first semester. The maximum students that can be admitted to an Open Elective Course is limited to forty (40) except for MOOC courses. If the student intake in a department is more than 40, then the maximum number of students that can be admitted to an Open Elective Course is equal to the student intake.

6.3 Every Course offered by the University Department is identified by a unique course code. Where first two letters denote Programme name (MS for Master of Science). Next three letters denote subject. This is followed by semester number such as 01, 02, 03,04. After semester number single alphabet stands for Core (C). Elective (E) and Open Elective course (O). The last two digits denote the serial number of the course in that category (C, E or O) in that programme. MSPHY01C02 MS – Master of Science, PHY – Physics 01 – First Semester C – Core 02– Serial number of the Core course of the programme

6.4 Any course including a core course of one Department can be offered as an Open Elective Course to students of other Departments

6.5 The minimum duration for completion of a two-year PG Programme is four (4) Semesters and the maximum period for completion is eight (8) Semesters from the date of registration. The minimum duration for completion of a one year PG programme in any subject is two (2) semesters and the maximum period for completion is four (4 semesters) four years from the date of registration.

6.6 No regular student shall register for more than 24 credits and less than 16 credits per Semester, subject to the provisions of the Programme concerned.

6.7 The total credits required for the successful completion of a four semester Programme will be between 72 to 80. For science subjects core credits should not exceed 70 per cent.

6.8 The Department Council shall design the Core, Elective and Open Courses including the detailed syllabus for each Programme offered by the Department. The Department Council shall have the freedom to introduce new courses and/or to modify/redesign existing Courses and replace any existing Course with a new Course to facilitate better exposure and training for the students, with the approval of the Faculty Council and the Academic Council.

7. EVALUATION

7.1 Evaluation of the students shall be done by the Faculty member who teaches the Course on the basis of Continuous Evaluation and an End Semester Examination. The proportion of the distribution of marks among End Semester Examination and Continuous Evaluation shall be 60:40. 10 percent of the scripts, subject to a minimum of 5 scripts per course will be valued by an External Examiner. If there is an average difference of more than 15 per cent in the marks awarded by the Internal and External Examiner, the scripts will be valued by one internal and External examiner, the scripts will be valued by one Internal and one External examiner together.

7.2 Continuous Evaluation includes Assignments, Seminars, periodic written examinations etc.

7.3 The allocation of marks for each component under Continuous Evaluation shall be in the following proportions:

Theory		Practical	
Components	% of marks	Components	% of marks
Test papers	40% (16 marks)	Tests	75% (30 marks)
Tutorial with viva, Seminar presentations,	40% (16 marks)	Record	25% (10 marks)

Discussion, Debate etc			
Assignment	20% (8 marks)		
Total Internal marks	40	Total internal marks	40

7.4 Mode of assessment i.e., administering of Test or Tutorial will be decided by individual departments

7.5 A copy of all records of Continuous Evaluation shall be maintained in electronic format in the Department and shall be made available for verification by the University.

7.5 Performance of each student in an assessment shall be intimated to him/her within two weeks of the conduct of test/ submission of assignment/ report.

8. CONDUCT OF THE END SEMESTER EXAMINATION

8.1 The End Semester Examinations of each semester will be conducted by the Controller of Examinations. It will be the responsibility of the Department to maintain a sufficient balance of different levels of questions in the Question Bank. The tabulation registers of each Semester shall be prepared and maintained by the Examination Branch. There shall be a minimum of one external examiner to ensure transparency in the conduct of examinations. The external examiners will be faculty members appointed from other Colleges/Departments of this University or from other Universities. The duration of End Semester Examination shall be specified in the curriculum.

8.2 The Board of Examiners will function as the Pass Board and will be called the Subject Examination Board with the Head of the Department/or a nominee of the Vice Chancellor when there is no University Department offering that Programme as its Chair

9. ATTENDANCE

9.1. The minimum attendance required for each Course shall be 60% of the total number of classes conducted for that semester. Those who secure the minimum attendance in a semester alone will be allowed to register for the End Semester Examination.

Condonation of attendance to a maximum of 10 days in a Semester subject to a maximum of two spells within a Programme will be granted by the Vice-Chancellor. Benefit of Condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meetings of the University Bodies and participation in extracurricular activities on production of genuine supporting documents with the recommendation of the Head of the Department concerned. A student who is not eligible for Condonation shall repeat the Course along with the subsequent batch.

10. GRADING

10.1 An alphabetical Grading System shall be adopted for the assessment of a student's performance in a Course. The grade is based on a 6 point scale. The following table gives the range of marks %, grade points and alphabetical grade.

Range of Marks %	**Grade Points**	**Alphabetical Grade**
90-100	9	A+
80-89	8	A
70-79	7	B+
60-69	6	B
50-59	5	C
Below 50	0	F

10.2 A minimum of grade point 5 (Grade C) is needed for the successful completion of a Course. A student who has failed in a Course can reappear for the End Semester Examination of the same Course along with the next batch without taking re-admission or choose another Course in the subsequent Semesters of the same programme to acquire the minimum credits needed for the completion of the Programme. There shall not be provision for improvement of CE and ESE. A student can sit the ESE again is she/he has successfully completed the CE requirements in a subsequent semester subject to the maximum durations permitted.

10.3 Performance of a student at the end of each Semester is indicated by the Semester Grade Point Average (SGPA) and is calculated by taking the weighted average of grade points of the Courses successfully completed. Following formula is used for the calculation. The average will be rounded off to two decimal places.

CGPA = Sum of (grade points in a course multiplied by its credit)

Sum of Credits of Courses

10.4 At the end of the Programme, the overall performance of a student is indicated by the Cumulative Grade Point Average (CGPA) and is calculated using the same formula given above.

10.5. Empirical formula for calculating the percentage of marks will be

% Marks = (CGPA x 10) +5.

10.6 Based on the CGPA overall letter grade of the student and classification shall be in the following way.

CGPA	**Overall Letter Grade**	**Classification**
8.5 and above	A+	First Class with Distinction
7.5 and above but less than 8.5	A	
6.5 and above but less than 7.5	B+	First Class
5.5 and above but less than 6.5	B	
5 and above but less than 5.5	C	Second Class

10.7 Appearance for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are compulsory and no Grade shall be awarded to a candidate if he/she is absent for CE/ESE or both.

10.8 A student who fails to complete the Programme/Semester can repeat the full Programme / Semester once, if the Department Council permits to do so. Absence in an examination will be marked zero.

10.9 No student shall be allowed to take more than eight/twelve consecutive Semesters for completing a four/six Semester Programme from the date of enrolment.

11. GRADE CARD

11.1. The Controller of Examinations shall issue the grade cards of all semesters and the consolidated grade card and certificates on completion of the programme, based on the details submitted by the Heads of the Departments concerned. This will be in digital form only.

11.2. The Grade Card shall contain the following

a) Title of the Courses taken as Core, Elective & Open Elective.
b) The credits associated with and grades awarded for each Course.
c) The number of credits (Core /Elective / Open) separately earned by the student and the SGPA.
d) The total credits (Core / Elective / Open) separately earned by a student till that Semester.

11.3. The consolidated grade statement issued on completion of the Programme shall contain the name of the Programme, the Department/School offering the Programme, the title of the Courses taken, the credits associated with each Course, grades awarded, the total credits (Core /Elective/Open) separately earned by the student, the CGPA and the class in which the student is placed. Rank Certificates will be issued based on CGPA calculated at the end of the last semester of that Programmes.

12. DEPARTMENT COUNCIL

12.1 All the Permanent and Contract teachers of the Department shall be the members of the Department Council.

12.2 The Department Council subject to these Regulations shall monitor every academic programme conducted in the Department.

12.3 Department Council shall prescribe the mode of conduct of courses, conduct of examinations and evaluation of the students.

12.4 An elected student representative also may attend the department council meeting where agenda related to academic matters / research activities of students are discussed

13. CURRICULUM COMMITTEE

13.1 There shall be a Curriculum Committee constituted by the Vice Chancellor to monitor and co-ordinate the working of the Choice based Credit Semester System.

13.2 A senior professor nominated by the Vice Chancellor shall be the convener of the Curriculum Committee.

13.3 The Committee shall consist of:

a) Vice-Chancellor or person nominated by VC (Chairperson)

b) The Convener of the Curriculum Committee (A professor of the University nominated by the Vice-Chancellor)
c) The Registrar -Secretary
d) The Controller of Examinations
e) Deans
f) The Heads of the Departments

13.4 The term of office of the Committee shall be two years, but the Committee once constituted shall continue in office until a reconstituted committee assumes office.

14. ACADEMIC GRIEVANCE REDRESSAL MECHANISM

14.1 Committees will be constituted at the Department and University levels to look into the written complaints regarding Continuous Evaluation (CE). Department Level Committee (DLC) will consist of the Department Council, and elected student representatives who is currently a student of that Programme of study. There will be one student representative for the post graduate programmes and one student representative for the doctoral programme.

14.2 University Level Committee (ULC) will consist of the Convenor of the Curriculum Committee, the concerned Dean, the concerned Head of the Department and a nominee of the Students' Union

14.3 Department Level Committee will be presided over by the HoD. Complaints should be submitted to the Department concerned within two weeks of publication of results of Continuous Evaluation (CE) and disposed of within two weeks of receipt of complaint. Appeals to University Level Committee should be made within two weeks of the decisions taken by Department Level Committee and disposed of within two weeks of the receipt of the complaint.

14.4 Complaints unsolved by the University Level Grievance Committee shall be placed before the Vice Chancellor.

15. TRANSITORY PROVISION

15.1 Not withstanding anything contained in these regulations, the shall for a period of one year (may be revised) from the date of coming into force of these regulations, the Vice Chancellor have the power to provide by order that these regulations shall be applied to any Programme with such modifications as may be necessary.

16. REPEAL

16.1 The Regulations now in force so far as they are applicable to programmes offered in the University Departments and to the extent they are inconsistent with these regulations are hereby repealed. In the case of any inconsistency between the implemented regulations of Choice based Credit Semester System and its application to any independent programme offered in a University Department, the former shall prevail.

Scheme and Syllabus for

M. Sc. Physics (Advanced Materials) Programme (CCSS)

For the University Physics Department w.e.f. 2020 admission onwards

I. About the Department

The Post Graduate Department of Physics of the Kannur University was established in 2003 at Edat, about two kilometres far from Payyanur town heading towards the south. The campus is calm and beautiful, away from the bustle and pollution of the city where modern buildings with all high-tech infrastructure facilities for the smooth functioning of the Post Graduate & Research programmes in Physics have been established with an intake of 20 students.

The aim of the Department is to impart up to date information and new knowledge materials as evolved from time to time to our students so as to meet the requirements of trained manpower in Physics towards the areas of teaching, research, engineering and other vocations. It is meant mainly to benefit the aspiring students of the northern part of Kerala. The University takes all efforts to develop this campus as a centre of excellence with well-qualified faculty and provides most modern techniques in teaching, with the well-equipped, enhanced computer and research laboratories. The Department has plans to introduce innovative programs in research leading to M. Phil and Ph.D. in the forthcoming years. The thrust area of teaching is chosen as Material Science which includes areas such as Thin Film Technology, Semiconductor Materials, Nanomaterials, Lasers and Optoelectronics, Polymer Materials, Composite Materials, Photovoltaic Energy Conversion, Ceramic Materials etc. The main thrust areas of research are Materials Science and Nuclear Physics.

The Post Graduate course has been designed with specialization in Materials Science and is equivalent to the other M.Sc. courses in Physics of the Kannur University and all the other universities at Kerala State.

II. Introduction to CBCS (Choice Based Credit System) Choice Based Credit System:

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill-based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enables the potential employers in assessing the performance of the candidates. Definitions: (i) 'Academic Programme' means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/ centre. (ii) 'Course' means a segment of a subject that is part of an Academic Programme. (iii) 'Programme Structure' means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity to University rules, eligibility criteria for admission. (iv) 'Core Course' means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course. (v) 'Elective Course' means an optional course to be selected by a student out of such courses offered in the same or any other Department/Centre. (vi) 'Open Elective' means an elective course which is available for students of all programmes, including students of the same department. Students of other Department will opt these courses subject to fulfilling the eligibility of criteria as laid down by the Department offering the course. (vii) 'Credit' means the value assigned to a course which indicates the level of instruction; One-hour lecture per week equals 1 Credit, 2 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course.

'SGPA' means Semester Grade Point Average calculated for individual semesters. (ix) 'CGPA' is Cumulative Grade Points Average calculated for all courses completed by the students at any point of time. CGPA is calculated each year for both the semesters clubbed together. (x) 'Grand CGPA' is calculated in the last year of the course by clubbing together a CGPA of two years, i.e., four semesters. Grand CGPA is being given in Transcript form. To benefit the student a formula for conversation of Grand CGPA into percentage marks is given in the Transcript.

III. Programme Objectives (PSOs):

- To develop strong student competencies in Physics and its applications in a technology-rich, interactive environment.
- To develop strong student skills in research, analysis and interpretation of complex information.
- To prepare the students to successfully compete for employment in Electronics, Manufacturing and Teaching and to offer a wide range of experience in research methods, data analysis to meet the industrial needs.

IV. Programme Outcomes (PCOs): On successful completion of the course a student will be able to:

- Apply knowledge and skill in the design and development of Electronics circuits to cater to the needs of Electronic Industry.
- Become professionally trained in the area of electronics, optical communication, nonlinear circuits, materials characterization and lasers.
- Excel in the research related to Physics and Materials characterization.
- Demonstrate highest standards of Actuarial ethical conduct and Professional Actuarial behaviour, critical, interpersonal and communication skills as well as a commitment to life-long learning.

V. M.Sc. Physics Programme Details

The duration of the M. Sc. Physics (Advanced Materials) programme (CCSS) shall be **2 (two)** years. This programme consists of **16 (sixteen)** theory courses, **3 (three)** lab courses, **1(one)** study tour and **1 (one)** project spread over **4 (four)** semesters. A student can earn **20 (twenty)** credits in 1^{st}, 2^{nd}, 4^{th} semester and **22 (twenty-two)** credits in 3^{rd} semester and total **82 (eighty-two)** credits in four semesters. Indirect grading patterns with **40%** internal and **60%** external marks will be followed. The course structure is as follows:

Theory Courses: There are sixteen theory courses - each with 4 credits - spread over four semesters in the M. Sc. programme. The distribution of the theory courses is as follows:

There are **10 (**ten**) core** courses, **5 (**five**) elective** courses and **01** (one) **open course** in the programme.

Practical Courses: The first three semesters will have a course on laboratory practical. Each course has a credit of 4 (four). A minimum of 16 (sixteen) experiments should be done and recorded in each semester. The practical examination will be conducted at the end of each semester at the Department by two examiners (one internal and the other external). The duration of the examination will be 6 (six) hours.

Project: In the fourth semester, there will be a project of credit 4 (four). The project should be very relevant and innovative in nature. It should be aimed to motivate the inquisitive and research aptitude of the students. The type of the project can be decided by the student and the guide (a faculty of the Department or other Department/University/Institution). For the conduction of the project work sufficient span of time will be allotted for the students and its evaluation will be scheduled at the end of the fourth semester. The project will be evaluated by two examiners. The distribution of credits is as follows: 2 for the report and 2 for the presentation of project work done and comprehensive viva-voce.

The courses in various semesters and the detailed syllabus of the programme are given below.

COURSES IN VARIOUS SEMESTERS

SEMESTER I

MSPHY01C01: MATHEMATICAL PHYSICS I (4C)

MSPHY01C02: CLASSICAL MECHANICS (4C)

MSPHY01C03: SOLID STATE PHYSICS (4C)

MSPHY01C04: ELECTRONICS (4C)

MSPHY01C05: PRACTICAL I – ELECTRONICS AND COMPUTER PROGRAMMING (4C)

SEMESTER II

MSPHY02C06: MATHEMATICAL PHYSICS II (4C)

MSPHY02C07: QUANTUM MECHANICS I (4C)

MSPHY02C08: NUCLEAR PHYSICS (4C)

MSPHY02C09: CLASSICAL ELECTRODYNAMICS (4C)

MSPHY02C10: PRACTICAL II – GENERAL PHYSICS (4C)

SEMESTER III

MSPHY03C11: QUANTUM MECHANICS II (4C)

MSPHY03E01: ATOMIC AND MOLECULAR SPECTROSCOPY (4C)

MSPHY03E02: MODERN OPTICS (4C)

MSPHY03E03: SEMICONDUCTING MATERIALS AND DEVICES (4C)

MSPHY03C12: PRACTICAL III – MODERN PHYSICS (4C)

MSPHY03C13: STUDY TOUR REPORT (1C)

SEMESTER IV

MSPHY04C14: STATISTICAL MECHANICS (4C)

MSPHY04E04: PARTICLE AND ASTROPHYSICS (4C)

MSPHY04E05: THIN FILM TECHNOLOGY (4C)

MSPHY04O01: PHOTOVOLTAIC ENERGY CONVERSION (4C)

MSPHY04O02: NANOSCIENCE AND TECHNOLOGY (4C)

MSPHY04O03: ENERGY PHYSICS (4C)

MSPHY04C15: PROJECT (3C)

THE MARKS AND CREDITS FOR VARIOUS COURSES

Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
		L	T/S	P	CE	ESE	Total	
Semester I								
MSPHY01C01	Mathematical Physics I	4	1	-	40	60	100	4
MSPHY01C02	Classical Mechanics	4	1	-	40	60	100	4
MSPHY01C03	Solid State Physics	4	1	-	40	60	100	4
MSPHY01C04	Electronics	4	1	-	40	60	100	4
MSPHY01C05	Practical I – Electronics and Computer Programming	-	-	10	40	60	100	4
Total for Semester I					**200**	**300**	**500**	**20**
Semester II								
MSPHY02C06	Mathematical Physics II	4	1	-	40	60	100	4
MSPHY02C07	Quantum Mechanics I	4	1	-	40	60	100	4
MSPHY02C08	Nuclear Physics	4	1	-	40	60	100	4
MSPHY02C09	Classical Electrodynamics	4	1	-	40	60	100	4

MSPHY02C10	Practical II – General Physics	-	-	10	40	60	100	4
Total for Semester II					**200**	**300**	**500**	**20**

Semester III								
MSPHY03C11	Quantum Mechanics II	4	1	-	40	60	100	4
MSPHY03E01	Atomic and Molecular Spectroscopy	4	1	-	40	60	100	4
MSPHY03E02	Modern Optics	2		-	40	60	100	4
MSPHY03E03	Semiconducting Materials and Devices	4	1	-	40	60	100	4
MSPHY03C12	Practical III – Modern Physics	-	-	10	40	60	100	4
MSPHY03C13	Study Tour Report	-	-	-	100	-	100	1
Total for Semester III					**300**	**300**	**600**	**21**
Semester IV								
MSPHY04C14	Statistical Mechanics	4	1	-	40	60	100	4
MSPHY04E04	Particle and Astrophysics	4	1	-	40	60	100	4
MSPHY04E05	Thin Film Technology	4	1	-	40	60	100	4

MSPHY04O01/02/03	Open Course	4	1	-	40	60	100	4
MSPHY04C15	Project	-	-	10	-	100	100	3
Total for Semester IV					**160**	**340**	**500**	**19**
Grand Total					**860**	**1240**	**2100**	**80**

Note: - PHY–Physics, C–Core Course, E–Elective Course, L–Lecture, T–Tutorial, S-Seminar and P–Practical

OPEN COURSE

Course Code	Title of the Course	Contact Hours/Week			Marks			Credits
		L	T/S	P	CE	ESE	Total	
Semester IV								
MSPHY04O01	Photovoltaic Energy Conversion	4	-	-	40	60	100	4
MSPHY04O02	Nanoscience and Technology	4	-	-	40	60	100	4
MSPHY04O03	Energy Physics	4	-	-	40	60	100	4

Note: - PHY–Physics, O–Open Course, L–Lecture, T–Tutorial, S-Seminar and P–Practical

DETAILED SYLLABUS

SEMESTER I

MSPHY01C01 MATHEMATICAL PHYSICS I

Objectives: This course is aimed to equip the students with the mathematical techniques used for developing strong background in the basic and advanced level problems. The course describes curvilinear coordinates, complex functions, and applications of complex theory, special functions, tensors and group theory.

Course outcome

The students can able

(i) To learn about the matrices and tensors relevant in physics.
(ii) To study about the gradient, divergent, and curl in an orthogonal curvilinear coordinate system and their applications in physics.
(iii) To understand the concept of complex theory.
(iv) To understand the Taylor/Laurent expansion of complex functions.
(v) To perform complex integrations using the contour integral method.
(vi) To know the concepts of residue theorem and application.
(vii) To apply Frobenius Method for Solving Second Order Ordinary Differential Equations
(viii) To describe special functions and their recurrence relations.
(ix) To know about beta and gamma functions with their advantages and properties.
(x) To apply theoretical knowledge of principles and concepts of Physics to practical problems.

MODULE I

Vectors: Rotation of Coordinates – Orthogonal Curvilinear Coordinates: Rectangular Cartesian, Circular Cylindrical and Spherical Polar Coordinates – Differential Vector Operators in Different Coordinate Systems (Gradient, Divergence, Curl & Laplacian Operators) – Laplace's equation – application to electrostatic field and wave equations.

MODULE II

Homogeneous and Inhomogeneous Linear Equations – Matrices: Basic Properties (Review only) – Orthogonal, Hermitian and Unitary Matrices – Diagonalization of Matrices – Simultaneous Diagonalization – Definition of Tensors – Contraction – Direct Product – Quotient rule – Pseudo Tensors – Metric Tensors – Dual tensors – Irreducible tensors – Kronecker Delta and Levi-Civita Tensors.

MODULE III

Function of Complex Variables: Introduction – Analytic Function – Cauchy-Riemann Conditions – Cauchy Integral Theorem: Contour Integrals – Stoke's Theorem Proof – Multiply Connected Regions – Cauchy Integral Formula – Laurent Expansion: Taylor Expansion and Laurent Series – Singularities – Calculus of Residues and Applications.

MODULE IV

Frobenius Method for Solving Second Order Ordinary Differential Equations with Variable Coefficients – Second Solution – Self-Adjoint Differential Equations – eigen functions and values, Boundary conditions, Hermitian operators and their properties, Schmidt orthogonalization, Completeness of functions – Special Functions: Gamma Function, Beta Function, Bessel Functions of First and Second Kinds: Generating Function, Recurrence Relations, Orthogonality, Neumann Function – Legendre Polynomials: Generating Function, Recurrence Relations, Rodrigue's Formula, Orthogonality – Associated Legendre Polynomials – Spherical Harmonics – Hermite Polynomials – Laguerre Polynomials.

Textbooks:

1. Arfken G.B and Weber H.J., Mathematical Methods for Physicists, Prism Books.
2. P. K. Chattopadhyaya, Mathematical Physics, New Age International.

References:

1. L. I. Pipes and L. R. Harvill, Applied Mathematics for Physicists and Engineers, McGraw Hill.
2. Sathyaprakash, Mathematical Physics, S. Chand & Co.
3. R. Courant and D. Hilbert, Methods of Mathematical Physics, Wiley Eastern.

MSPHY01C02 CLASSICAL MECHANICS

Objectives: This course is aimed to provide basic and advanced concepts in classical mechanics, which acts as a bridge to quantum mechanics and then quantum field theory. The course Starts with D Alembert's principle using Newtonian mechanics utilising dependent coordinates.The theory then modified by using independent coordinate system to attain Lagrange's equation of motion. Due to restricted degrees of freedom, Lagrange's equation again modified using Legendre transformation to achieve Hamiltonian equations of motion which are 2n first order equations as compared to n second order Lagrange's equations of motion. Hamilton canonical equation of motion again modified to Hamilton-Jacobi equation of motion which is a partial first order differential equation of motion. Even Though partial differential equation is complicated to solve, we can use the techniques of separation of variables to reduce the equation to simple quadratures which are easy to solve. The paper also gives insight to central force problems, theory of small oscillations, Kepler's problem, Rigid body dynamics and Euler's equations, Concepts of special and general theory of relativity, Nonlinear dynamical systems and chaos.

Course Outcome

(i) Students are able to learn the concepts of Lagrangian and Hamiltonian mechanics and use them to solve problems in mechanics. Learn the concepts like generating functions, Poisson brackets and Hamilton Jacobi equations. The action angle variables concepts to find the frequency of motion of the heavenly bodies.

(ii) To equip the students to deal with central force problems and analyse Kepler's laws to find the trajectory of the planetary motion.

(iii) To inculcate the students the concepts of special and general theory of relativity and related problems.

(iv) To acquaint the students about the theory of small oscillations and Euler's equations of motions of rigid bodies.

(v) To analyse nonlinear dynamical systems and to explain the concepts of classical chaos.

MODULE I

Constraints and Generalized Coordinates – D' Alembert's Principle and Lagrange's Equations – Velocity Dependent Potentials – Simple Applications – Hamilton's Principle – Elementary Idea of Calculus of Variation – Euler-Lagrange Equation – Lagrange's Equation from Hamilton's Principle – Hamiltonian Function – Central Force Problem – Scattering in a central force field – Equivalent One Dimensional Problem - Classification of Orbits – The Kepler Problem.

Small Oscillations – Formulation of the Problem – Eigenvalue Equation – Normal Coordinates – Free Vibrations of a Linear Triatomic Molecule.

MODULE II

Configuration Space and Phase Space – Legendre Transformation – Hamilton's Canonical Equations – Principle of Least Action – Applications of Hamilton's Equations: Two dimensional Isotropic Harmonic Oscillator and Charged Particle in an Electromagnetic Field – Canonical Transformations – Examples – Infinitesimal Canonical Transformation – Poisson Brackets: Properties – Equation of Motion in Poisson Bracket Form – Angular Momentum Poisson Bracket Relations.

MODULE III

Hamilton Jacobi Equation for Hamilton's Principal Function and Hamilton's Characteristic Function – Harmonic Oscillator Problem – Action Angle Variables – Hamilton Jacobi Formulation of Kepler Problem – Hamilton Jacobi Equation and Schrodinger Equation.

MODULE IV

Space Fixed and Body Fixed Systems of Coordinates – Description of Rigid Body Motion – Direction Cosines – Euler Angles – Infinitesimal Rotations – Rate of Change of a Vector – Centrifugal and Coriolis Forces – Moment of Inertia Tensor – Euler's Equation of Motion.

Text Books:

1. Goldstein, Classical Mechanics, Pearson Education.

References:

1. N. C. Rana and P. S. Joag, Classical Mechanics, Tata McGraw Hill.
2. R. G. Takwale and P. S. Puranic, Introduction to Classical Mechanics, TMH.

3. V. B. Bhatia, Classical Mechanics, Narosa Publishers.

4. A.J. Griffith, Classical Mechanics, McGraw Hill.

5. Kiran C. Guptha, Classical Mechanics of Particles and Rigid Bodies, New Age International.

MSPHY01C03 SOLID STATE PHYSICS

Objectives: To understand and familiarize fundamentals of crystals, lattice vibrations, band theory, and dielectric, magnetic and superconducting properties of materials.

Outcome:

(i) Discuss crystal physics, lattice vibrations, and models of thermal properties and band theory of solids.
(ii) To understand the concept of band theory of solid and how to classify them
(iii) Explain the theoretical concepts of semiconductors, dielectric, magnetic and superconducting materials.
(iv) To describe the concepts of different theories of specific heat capacity.
(v) To apply the concepts in condensed matter physics to meet the challenges.
(vi) To describe the concepts of superconductivity theories and application

MODULE I

Periodic Arrays of Atoms – Symmetry elements of a crystal, Types of space lattices, Miller indices, Diamond Structure, NaCI Structure, BCC, FCC, HCP structures with examples_– Fundamental Types of Lattices – Index System for Crystal Planes – Simple Crystal Structures – Crystal Binding – Elementary Ideas of Point Defects and Dislocations – Generation and Absorption of X-rays – Diffraction of Waves by Crystals – Reciprocal Lattice – Scattered Wave Amplitude – Brillouin Zones – Fourier Analysis of the Basis – Structure Factor – Atomic From Factor – Vander Waals interaction, Cohesive energy of inert gas crystals, Madelung interaction, Cohesive energy of ionic crystals, Covalent bonding, Metallic bonding, Hydrogen - bonded crystals.

MODULE II

Vibration of Monatomic and Diatomic Linear Lattices – Quantization of Elastic Waves – Phonon Momentum – Phonon Heat Capacity – Density of States in One and Three

Dimensions – Einstein and Debye Models of specific heat – Free Electron Gas – Drude-Lorentz Theory – Electrical Resistivity versus Temperature – Free Electron Gas in Three Dimension – Fermi Statistics and Fermi Dirac Distribution – Heat Capacity of the Free Electron Gas – Electrical Conductivity – Hall Effect.

Energy Spectra of Atoms, Molecules and Solids – Free Electron Model and Origin of Energy Gap – Bloch Theorem – Kronig-Penney Model – Equation of Motion of Electrons in Energy Bands – Holes – Effective Mass – Intrinsic Carrier Concentration in Conduction Band and Valence Band – Impurity Conductivity – Donor States – Acceptor States.

MODULE III

Superconductivity: Experimental Survey – Occurrence – Meissner Effect – Heat Capacity – Energy gap – Isotope Effect – Theoretical Survey – Thermodynamics of the Superconducting Transition – London Equation – Coherence Length – BCS Theory of Superconductivity (qualitative only) – Tunneling – The Josephson Effect.

Diamagnetism: Langevin Equation – Quantum Theory of Paramagnetism – Paramagnetic Susceptibility of Conduction Electrons – Ferromagnetic Order: Curie Point and the Exchange Integral – Magnons – Ferromagnetism – Antiferromagnetism – Neel's Model of Antiferromagnetism and Ferrimagnetism, Spin Waves – Elementary Ideas of Piezo, Pyro and FerroElectricity.

MODULE IV

Hall effect- Quantum Hall effect- Nanostructures-size effect- Quantum dot-Quantum wire – Quantum well-carbon nanostructures- polarities- excitons-topological aspects

Text Books:

1. C. Kittel, Introduction to Solid State Physics, John Willey.
2. A. J. Dekker, Solid State Physics, Addison Wesley Macmillan.
3. Michael P. Marder, Condensed matter Physics, John Willey.
4. Steven H. Simon, The Oxford Solid State Basics

References:

1. Omar M. A., Elementary Solid State Physics, Addison Wesley.
2. Wahab, Solid State Physics, Narosa Publications.

3. Asaroff V., Introduction to Solids, TMH.

MSPHY01C04 ELECTRONICS

Objectives: This course is aimed to introduce the students with the basic knowledge of analog and digital circuits. The course illustrates the concepts of operational amplifiers and their properties along with various linear and non-linear applications. Also, different kinds of filters are introduced as well as the design criteria of filters for specified bands are also implemented in this course. In addition, this course aims to provide general ideas on various components of digital electronic devices and fundamentals of microprocessors.

Outcomes:

(i) To equip the students to understand the basics of operational amplifiers.
(ii) To summarize the applications of operational amplifiers based devices.
(iii) To equip the students to explain various components in digital electronic devices.
(iv) To give key insight into microprocessors.

MODULE I

Introduction to Operational Amplifiers – Equivalent Circuit – Ideal Characteristics – Inverting and Non-Inverting Operational Amplifiers – Op-Amp Parameters – Concept of Virtual Ground – Voltage Gain – General Description of Various Stages in Op-Amp – Awareness of Type 741 Op-Amp – Frequency Response of Op- Amp – Open Loop and Closed Loop Frequency Response – General Idea of Frequency Compensation – Slew Rate and Slew Rate Equation.

MODULE II

Linear Applications of Op-Amp: Summing, Averaging and Scaling Amplifiers in the Inverting Mode – Summing and Averaging Amplifiers in the Non-Inverting Mode – Voltage to Current and Current to Voltage Converters – Integrator and Differentiator.

Non-Linear Op-Amp Circuits: Voltage Comparators – Schmitt Trigger – Logarithmic Amplifiers – Square Wave, Sawtooth Wave and Triangular Wave Generators.

Filters: Introduction and General Characteristics – Active Filters and their Designing: First Order and Second Order Low-Pass, High-Pass, Band-Pass, Band-Reject and All Pass Filters.

MODULE III

Multiplexer and Demultiplexer – Applications of Multiplexers Flip Flops and Timing Circuits – Registers: Different Types of Registers and Applications of Shift Registers – Counters: Synchronous Counters, Asynchronous Counters, Decade Counters and Mod 8 Ripple Counter- A/D and D/A Converters: R-2R Ladder and Successive Approximation Type ADC.

MODULE IV

Microprocessors – Microcomputers – 8085 Microprocessor – Various Operations of Microprocessors – Microprocessor Communication and Bus Timing – 8085 Bus Structure – Pin Diagram of 8085 MPU.

Text books:

1. K. R. Botker, Integrated Circuits, Khanna Publishers.
2. Ramakant A. Gayakward, Op-Amps and Linear Integrated Circuits, Pearson Education.
3. Jacob Millman & Chritos C. Halkias, Integrated Electronics, McGraw Hill.
4. Ramesh Gaonkar, Microprocessor Architecture, Programming and Application with the 8085, Penram International Publishing Company.
5. Malvino & Leach, Digital Principles and Applications, TMH.

References:

1. A. Anandkumar, Fundamentals of Digital Circuits, Prentice Hall of India.
2. T. L. Floyd, Digital Fundamentals, Prentice Hall.
3. Teaodare F. Bograt Jr., Introduction to Digital Circuits, McGraw Hill.

MSPHY01C05 PRACTICAL I - ELECTRONICS AND COMPUTER PROGRAMMING

(At least 16 experiments should be done; 8 from each part**)**

Objectives: Design, construct and verify various electronics circuits and object oriented C++ programmes to solve numerical problems.

Outcome:

(i) To design and construct various electronic circuits and its validation.
(ii) To calculate error in various electronics experiments.
(iii) To develop programming skills in C++ programming.

List of Experiments:

Part I:

1. FET Characteristics – To determine the characteristics of a JFET and the transistor parameters.
2. Voltage regulation using transistors with feedback (Regulation characteristic with load for different input voltages)
3. Characteristics of silicon controlled rectifier (half wave and full wave).
4. Two stage RC coupled amplifier (I/O resistance with and without feedback).
5. Negative feedback amplifier (I/O resistance with and without feedback).
6. RC coupled FET amplifier – Common source (frequency response & I/O resistance).
7. Differential amplifier using transistors (Frequency response and CMRR).
8. Amplitude modulation and detection using transistors (modulation index and recovery of modulating signal).
9. Darlington pair amplifier (gain, frequency response and I/O resistance)
10. Wein bridge oscillator using OP AMP (for different frequency distortions due to feedback resistance).
11. Sawtooth generator using transistors (for different frequencies)
12. Miller sweep circuits using OP AMP (for different frequencies)
13. IC 741 Inverting and Non-inverting amplifiers.
14. Schmitt trigger using OP AMP (Trace hysteresis curve, Determination of LTP and UTP).
15. Schmitt trigger using Transistor (Trace hysteresis curve, Determination of LTP and UTP).
16. OPAMP analog simulation and computation – To integrate the given second order differential equation.
17. OPAMP- Analog integration and differentiation (bode plot).
18. OP AMP- Low pass, High pass and band pass filters – frequency response curve.

19. Complementary symmetry amplifier – frequency response, I/O resistance.
20. Binary adders – HA and FA using Nand gates
21. D/A Converter - a) Binary weighted resistors b) R-2R ladder (Four bit or more) – To verify output for different digital inputs.
22. Study of flip-flops (RS and JK using 7400 IC) – To verify the truth tables.
23. IC 555 timer – Astable and Monostable multivibrators.
24. IC555 timers – Bistable multivibrators.
25. IC 555 timer – VCO and Saw tooth wave generators.

Part II:

(C language or Java or both of them can be used for doing the experiments)

1. Write a program for studying the variation of magnetic field along the axis of a coil
2. Write a program to generate random numbers using a mid-square method and to simulate random walk using these random numbers.
3. Write a program for generating square wave, triangular wave and sawtooth wave using Fourier technique.
4. Write a program to find the roots of a nonlinear equation by Newton-Raphson method.
5. Write a program to interpolate the value of a function using Lagrange's interpolating polynomials.
6. Write programs for numerical integration by using Trapezoidal and Simpson's methods.
7. Write a program to perform matrix addition, subtraction and multiplication and to find the trace and transpose of a matrix.
8. Write a program to find the Taylor series expansion of the given function.
9. Write a program to find the solutions of the first order differential equation using Runge- Kutta method.
10. Write a program to plot the Maxwell-Boltzmann distribution and to prove the equipartition theorem.
11. Write a program to plot Bose-Einstein distribution and to prove the Stefan-Boltzmann law and Wein's displacement law.
12. Write a program to plot Fermi-Dirac distribution.

13. Write a program to draw i-d and i_1-i_2 curves for 80^0, 60^0, 45^0 and 10^0 prisms using equations by assuming a refractive index.
14. Write a program to simulate the charged particle in an electromagnetic field.
15. Write a program for least square method for curve fitting.
16. Write a program to study the resonance in an LCR circuit.
17. Write a program to study the trajectory of an ion in Cyclotron Accelerator.
18. Write a program to study the barrier penetration (wave function outside and inside a barrier)
19. Write a program to plot the trajectory of a particle undergoing random motion in one and two dimensions.
20. Write a program to plot momentum versus position for the following systems (i) damped (ii) undamped oscillations

References:

1. Paul B. Zbar and Malvine A. P., Basic Electronics, Tata McGraw Hill.
2. Begrat R. Brown J., Experiments for Electronic Devices and Circuits, Merrill International Series.
3. Buchla, Digital Experiments, Merrill International Series.
4. Jain R.P. and Anand M.M.S., Digital Electronics Practice Using ICs, Tata McGraw Hill.
5. Subramanian V. S., Experiments in Electronics, McMillan.
6. Poorna Chandra Rao and Sasikala B., Hand Book of Experiments in Electronics and Communication Engineering.
7. Balagurusamy E, Programming in ANSI C, Tata McGraw Hill.
8. Yashavant Kanetkar, Let Us C, BPB Publications.
9. Balagurusamy E,Numerical Methods, Tata McGraw-Hill

SEMESTER II

MSPHY02C06 MATHEMATICAL PHYSICS II

Objectives:

This course is aimed to equip the students with the mathematical skill to solve problems in advanced physics. The course describes Fourier series, Fourier and Laplace transforms, Applications of Fourier and Laplace problems in physical problems, Green's functions for solving differential equations, integral equations, Green's functions, theory of groups and chaos.

Course Outcome

(i) Develop analytical skills to solve problems in different areas of physics using Fourier series, Fourier and Laplace transforms.
(ii) Learn to use Laplace transform methods to solve differential equations.
(iii) Introduce the Fourier series and its application to the solution of partial differential equations
(iv) To illustrate and apply concepts of group theory in physics problems, which is a prerequisite for deeper understanding of crystallography, particle physics, quantum mechanics and energy bands in solids.
(v) Learn how to apply symmetry operations using group theory.
(vi) To familiarize with the method Green's function to solve non-homogeneous linear differential equations.
(vii) To find the solutions of the integral equation using different methods like Neumann Series method, Separable Kernel Method and using Hilbert-Schmidt Theory.
(viii) Know about the basic ideas of nonlinear equations and chaos.

MODULE I

Fourier Series – Introduction and Problems – Integral Transforms – Properties – Fourier Transform and Properties – Fourier Transform of Derivatives – Convolution Theorem – Laplace Transform and Properties – Laplace Transform of Derivatives – Convolution Theorem – Inverse Laplace Transform – Convolution Theorem.

MODULE II

Integral Equations: Transformation of a Differential Equation into an Integral Equation – Integral Transforms and Generating Functions – Neumann Series – Separable Kernal Method – Hilbert-Schmidt Theory.

Green's function: Properties – One Dimensional Green's Function – Problems – EigenFunction Expansion.

MODULE III

Groups: General Properties – Multiplication Table – Consequences – Symmetry Group of Square and Triangle – Permutation Group – Subgroups – Conjugate Elements and Classes – Direct Product Groups – Isomorphism and Homomorphism – Cyclic Group – Factor Group – Representation of a Group – Types of Representation – Schur's Lemmas – Orthogonality Theorem and Proof – Geometrical Interpretation – Character of a Representation – Character Table – Basic Ideas of Continuous Groups – SU(2) and SU(3) Groups.

MODULE IV

Chaos: Introduction – Logistic map – Critical Points and Bifurcations – Feigenbaum Number – Fractals – Examples.

Text books:

1. Arfken G. B and Weber H. J., Mathematical Methods for Physicists, Prism Books.
2. A. W. Joshi, Group Theory for Physicists, Wiley Eastern.
3. K. F. Riley and Hobson, Mathematical Methods for Physicists and Engineers, Cambridge.
4. Kathleen T. Aligood, Tim and James, Chaos: An Introduction to Dynamical Systems, Springer.
5. Michel Tabor, Chaos and Integrability in Nonlinear Dynamics, Wiley Eastern.

References:

1. Pipes and Harvil, Applied Mathematics for Physicists and Engineers, McGraw Hill.
2. Sathyaprakash, Mathematical Physics, S. Chand & CO
3. R. Courant and D. Gilbert, Methods of Mathematical Physics, Wiley Eastern.
4. M. Kumar, Deterministic Chaos, University Press.

MSPHY02C07 QUANTUM MECHANICS I

Objectives: This course on Quantum Mechanics- I gives the emphasis on the basic principles, the calculational techniques and the inner consistency and beauty of the theory. For this, a Hibert space formulation of the basic principles and the equation of motion are adopted at the outset. The treatment of linear vector spaces, matrices and the theory of angular momentum is given in a more detailed way. Applications to particular problems are taken up only to illustrate the principle or technique under discussion. Also, the Hilbert space formalism, which provides a unified view of the different formulation of non-relativistic quantum mechanics. Schroedinger's and Heisenberg's formulations appear merely as different representations, analogous respectively to the Hamilton-Jacobi theory and the Hamilton's formalism in classical mechanics.

Course Outcome

(i) The main outcome of the course is to learn the concepts of Linear vector spaces, an imaginary space with infinite degrees of freedom. This enables the students to define the concepts like operators, bra and ket notation for linear vector space and the representation of vectors and operators in matrix form.

(ii) The fundamental postulates of quantum mechanics and the concept of physical observable and measurement of the complex state and the fact that the physical observables or measurable quantities like energy, angular momentum, linear momentum etc. are quantized can be learnt by the students in an effective way.

(iii) To inculcate the students the concepts of quantum dynamics. Familiarize with different pictures like Shroedinger, Heisenberg and the interaction pictures and apply them to solve the Linear Harmonic Oscillator problem and the Hydrogen atom.

(iv) To give a deep insight into the quantum theory of angular momentum. Eigenvalues and eigenvectors associated with angular momentum. Matrix representation of angular momentum and the acquaintance of the student's orbital angular momentum and spin angular momentum components. Students can also learn the addition of angular momentum.

(v) Also, learnt the symmetries and conservation law and the space time symmetries.

(vi) Different approximation methods such as variational method and the stationary perturbation method can be familiarized which is used to solve the ground state energy of helium atom.

MODULE I

Linear Vector Space – Ortho Normal Basis – Unitary Space – Hilbert Space – Completeness – Closure Property – Operators: Different Types – Commuting operators – Dirac Notation – Matrix Representation of Vectors, Operators and Bases – Unitary Transformations – Change of Basis – Coordinate and Momentum Representation.

Fundamental Postulates – The Equation of Motion – Schrodinger, Heisenberg and Interaction Pictures – Uncertainty Principles – Time Energy Uncertainty Relation – Linear Harmonic Oscillator in Schrodinger and Heisenberg Pictures.

MODULE II

Definition of Angular Momentum – Eigen Values and Eigen Vectors – Angular Momentum Matrices – Pauli Spin Matrices – Orbital Angular Momentum – Angular Momentum and Rotation – Euler Angles – Addition of Angular Momentum – Clebsch Gordan Coefficients – Theory of Hydrogen Atom.

MODULE III

Space-time Symmetries – Displacement in Space and Time – Space Rotation – Space Inversion – Time Reversal – Identical Particles – Symmetric and Antisymmetric Wave Functions – Pauli's Exclusion Principle – Spin and Statistics – Two Electron Systems – Helium Atom.

MODULE IV

Variational Method for Bound States – Ground state of Helium Atom – Time Independent Perturbation Theory – Non-degenerate Case – Degenerate case – Anharmonic Oscillator – Stark and Zeeman Effects in Hydrogen Atom.

Text Books:

1. V. K. Thankappan, Quantum Mechanics, Wiley Eastern.
2. Ghatak and Lokanathan, Quantum Mechanics, MacMillan.
3. Amit Goswami, Quantum Mechanics, Wm. C. Brown Publishers.
4. Bransden and Joachain, Introduction to Quantum Mechanics, ELBS.
5. G. Aruldas, Quantum Mechanics, PHI.

References:

1. L. L. Schiff, Quantum Mechanics, McGraw Hill.

2. J. J. Sakurai, Modern Quantum Mechanics, Addison Wesley.
3. Powell and Crasemann, Quantum Mechanics, Addison Wesley.
4. Stephen Gasirowicz, Quantum Physics, Wiley Eastern.
5. A. Messiah, Quantum Mechanics, John Wiley & Sons.
6. Cohen Tannoudji, C. Diub and Laloe, Quantum Mechanics, Wiley Eastern.
7. Eugence Merzbacher, Quantum Mechanics.
8. P. A. M. Dirac, Principles of Quantum Mechanics.

MSPHY02C08 NUCLEAR PHYSICS

Objectives:

Nuclear physics is the field of physics that studies atomic nuclei and their constituents and interactions. Nuclear physics is the study of the protons and neutrons at the centre of an atom and the interactions that hold them together in a space just a few femto meters across. The main objective is to provide a basic knowledge about nuclear models, the theory behind the nuclear forces, scattering cross sections, nuclear fission and fusion reactions and their characteristics.

Course Outcome:

(i) The students will have a basic knowledge of nuclear size, shape, binding energy. etc and also the characteristics of nuclear force in detail.
(ii) The students will be able to gain knowledge about various nuclear models such as liquid drop model, shell model, collective model and Nilson model.
(iii) The students can acquire knowledge about nuclear reactions and its application in the nuclear fusion and fission process.
(iv) The students will also learn diagnostic nuclear medicine and therapeutic nuclear medicines.
(v) Students will have a wide understanding regarding alpha, beta and gamma decay with corresponding selection rules.

MODULE I

Radioactivity: Radioactive Decay Law – Types of Decays – Alpha particle Decay – Heavy Particle Decay or Cluster radioactivity - Natural Radioactivity – Radioactive Dating – Gamma Transitions – Measurement of Gamma Ray Energy – Lifetimes – Multiple Moments – Decay Rate Formula – Selection Rules – Angular Correlation and Internal Conversion – Beta Decay – Simple Theory of Beta Decay – Fermi-Kurie Plot – Comparative Half-Life – Allowed and Forbidden Transitions – Selection Rules – Parity Violation in Beta Decay – Neutrinos. Double Beta Decay (qualitative).

MODULE II

Nuclear Forces: Properties – General Characteristic of Nuclear Forces – The Deuteron and Two Nucleon Scattering Cross Sections – Low Energy n-p Scattering – Partial Waves – Phase Shift – Singlet and Triplet Potentials – Effective Range Theory – p-p Scattering – Yukawa's Theory of Nuclear Forces(qualitative) – Nuclear Binding Energy – Semi Empirical Mass Formula.

MODULE III

Nuclear Models: Liquid Drop Model – Shell Model – Spin Orbit Coupling – Spin and Parities of Ground States – Magnetic Moments – Quadrupole Moment and Schmidt Limits-Isospin Symmetry – Single Particle Orbits in a Well – Collective Model: Rotational and Vibration States – Nilsson Model.

MODULE IV

Nuclear Reactions and Applications: Nuclear Fission – Characteristics of Fission – Mass Distribution of Fission Fragments – Energy in Fission – Neutrons Released in Fission – Cross Sections – Fission Reactors Operating with Natural Uranium as Fuel – Fission and Thermonuclear Energy – Breeder Reactor – Controlled Fusion Energy – Qualitative Treatment of Applications of Nuclear Fusion – Diagnostic Nuclear Medicine and Therapeutic Nuclear Medicines.

Textbooks:

1. Kenneth S. Krane, Introduction to Nuclear Physics, John Wiley.
2. J. S. Lilley, Nuclear Physics: Principles and Applications, John Wiley.
3. G. F. Knoll, Nuclear Radiation Detector and Measurement, Wiley.
4. Herald A. Engel, Introduction to Nuclear Physics, Addison Wesely.

5. S. B. Patel, An Introduction to Nuclear Physics, New Age International.

References:

1. Samuel M. Wong, Introductory Nuclear Physics, Prentice Hall of India.
2. S. G. Nilsson & I. Ragnarsson, Shapes and Shells and Nuclear Structure, Cambridge University Press.
3. Marmier & Sheldon, Physics of Nuclei and Particles, Vol. II, Academic Press.
4. Burcharm & Jones, Nuclear and Particle Physics, Longman.
5. Roy R. K. and Nigam P. P., Nuclear Physics, Tata McGraw Hill.
6. Cohen B. L., Concepts of Nuclear Physics, Tata McGraw Hill.

MSPHY02C09 CLASSICAL ELECTRODYNAMICS

Objectives: This course covers linear and non-linear optical phenomenon, propagation of electromagnetic waves, relativistic electrodynamics, radiation and antenna theory.

Outcome:

(i) To demonstrate the linear and nonlinear optical phenomena.
(ii) To explain and discuss propagation of electromagnetic waves through different media.
(iii) To restate formulations and relativistic effects in electrodynamics.
(iv) To analyze the propagation of electromagnetic waves through waveguides.
(v) To use radiation theory in developing different antennas.

MODULE I

Electromagnetic Waves in Linear Media – The Flow of Electromagnetic Energy – Poynting Vector – Boundary Conditions – Plane Monochromatic Waves – Polarization of Plane Waves – Linear, Circular, Elliptic etc.

Reflection and Refraction of Electromagnetic Waves at a Plane Surface Between Dielectric Media: Normal Incidence and Oblique Incidence – Brewster's Angle – Critical Angle – Complex Fresnel Coefficients – Reflection from a Conducting Plane – Reflection and Transmission by a Thin Layer Interface.

MODULE II

Propagation of Electromagnetic Waves Between Parallel Conducting Plates – Transverse Electromagnetic Waves (TEM) – Equation for TE Modes – TM or E Mode – TE or M Mode – Properties of the TE and TM Modes – TE Modes for Rectangular Waveguide – TM Mode for Rectangular Waveguide – Resonant Cavities – Resonant Frequencies for a Cylindrical Cavity – TM and TE Modes – Power Losses and Q Value for a Cavity – Cylindrical Dielectric Waveguide.

MODULE III

Radiation from Hertzian dipole- half wave dipole antenna-quarter wave monopole antenna-antenna characteristics-antenna arrays- effective area and Friji's equations

MODULE IV

Uniform E and B Fields – Non-uniform Fields – Diffusion Across Magnetic Fields – Time Varying E and B Fields - Adiabatic Invariants: First, Second and Third Adiabatic Invariants.

Geometry of Space-Time – Lorentz Transformation as an Orthogonal Transformation – Covariant Form of Electromagnetic Equations – The Electromagnetic Field Tensor – Transformation Law for Electromagnetic Field – The Field of Uniformly Moving Point Charge

Textbooks:

1. Capri A. Z. and Pant P.V., Introduction to Electromagnetics, Narosa Publications.
2. John R. Reitz, Frederic J. Milford and Robert W. Christy, Foundations of Electromagnetic Theory, Narosa Publications.
3. David.J. Griffiths, Introductions to Electrodynamics, Prentice Hall.
4. Chen. F. F., Introduction to Plasma Physics and Controlled Fusion, Plenum.

References:

1. Jackson J.D, Classical Electrodynamics, 3rd Edition, John Wiley.
2. David Cheng, Field and Wave Electromagnetics, Pearson Education Asia.
3. Sadique, Electromagnetics.

4. Puri S. P, Classical Electromagnetics, 2^{nd} Edition, Tata McGraw Hill.
5. Loud B. B, Electromagnetics, 4^{th} Edition, Wiley Eastern.
6. Chopra K. K. and Agarwal G. C., Electromagnetic Theory, 4^{th} Edition, K. Nath and Co., Meerut.

MSPHY02C10 PRACTICAL II – GENERAL PHYSICS

(At least 16 experiments should be done)

Objectives: Demonstrate and understand various advanced physics experiments for acquiring fundamental concepts and analyse various experimental data

Outcome

(i) To measure and analyse various physical quantities.

(ii) To calculate error in various advanced physics experiments.

(iii) To develop experimental skills

(iv) To analyse and point out results of experimental data.

List of experiments:

1. Meyer's oscillating disc – To determine the viscosity of the given liquid.
2. Cornu's hyperbolic fringes – Determination of Y, σ and K with Pyrex.
3. Cornu's elliptical fringes – Determination of Y, σ and K with glass.
4. Stefan's constant – Determination of Stefan's constant.
5. Thermocouple – Constants, neutral and inversion temperatures.
6. Lee's disc – K of a liquid/ powder and air using thermocouple.
7. Hysteresis – B-H curves.
8. Maxwell's LC bridge – Determination of R and L of a given coil and C of a condenser.
9. Frequency Bridge – Construction of an oscillator and determination of frequency.

10. Quincke's method – Susceptibility of a liquid at different concentrations.

11. Guoy's method – Susceptibility of glass and aluminum.

12. Cauchy's constants – Determination of Cauchy's constants of sodium light.

13. Laser – Diameter of a thin wire.

14. Laser – Determination of slit width.

15. Laser – Determination of refractive index of a mirror substrate.

16. Laser – Study of intensity distribution and divergence of the beam.

17. Laser – Determination of the pitch of a screw.

18. Fabry-Perot Etalon – λ and thickness of air film.

19. Koenig's method – Determination of Y and σ.

20. Searle's optical interferometer – Determination of Y.

21. Vibrating strip – Determination of mode constants.

22. Expansion of crystal – By optical interference method.

23. Hydrogen spectrum – Series limits and Rydberg constant.

24. Photoelectric effect – Electronic charge and work function of metal

25. Photoelectric cell – Study of elliptically polarized light using deadbeat galvanometer, quarter wave plate, and nicol prism.

26. Fresnel's formula – Verification of Fresnel's formula for the reflection.

References:

1. Worsnop B. L. and Flint H. T., Advanced Practical Physics for Students, Methuen & Co.
2. Gupta S. L. and Kumar, Practical Physics, Pragathi Prakashan.
3. Smith E.V., Manual of Experiments in Applied Physics, Butterworth.

4. Dunlap R. A., Experimental Physics, Academic Press.
5. Malacara D., Methods of Experimental Physics, Oxford University Press.

SEMESTER III

MSPHY03C11 QUANTUM MECHANICS II

Objectives: One of the objectives of the course is to give a detailed description of the quantum theory of scattering. The experimental setup to the scattering problem and the concept of partial wave analysis is provided in the course to give an insight into the interaction involving the microscopic word. The theory of scattering is the important tool to peep into the world of microphysics. The topic on time dependent problems deals with the transition probability of the particles to be found in the final state due to time dependent perturbation or disturbance. Also, deals with the probability of transitions due to constant perturbation, transition to continuum and transition probability due to harmonic perturbation. The relativistic wave equation and the failure to consider Klein-Gordon wave equation as the true relativistic wave equation is discussed. The negative energy density and the probability current densities are also discussed in depth. The concept of Dirac equation and the Dirac matrices and the comparison with Pauli spin matrices are also in the scope of the study of the paper.

Course Outcome

(i) The theory on Scattering enable the students to understand the force force responsible for scattering which in turn give a microscopic description of the concepts

(ii) The time dependent perturbation theory acquaints the students with a deep knowledge regarding the transition probability between the different stationary states due to constant perturbation, harmonic perturbation, transition to continuum states etc.

(iii) The concept of negative energy states and the true relativistic wave equation is the concept involved by studying the relativistic wave equation. The students become familiar with the concepts like Bose-Einstein statistics and Fermi-Dirac statistics.

(iv) Familiarisation of the students with Spin-Orbit interaction and the Born-Oppenheimer approximation enables the student's semi classical approach which then leads to the quantum theory of spectrum of atomic and molecules.

(v) To inculcate the students the concept of Hole theory which leads to the negative energy states which is the integral part of the completion of the relativistic quantum mechanics.

(vi) The concept of field quantization and Lagrangian and Hamiltinoa density are the other outcomes of the theory.

MODULE I

Spin-Orbit Interaction – Fine Structure of Hydrogen Atom – Anomalous Zeeman Effect – The Hartree Equation for Atoms – Molecular Structure – Born-Oppenheimer Approximation – Molecular Orbital Method and Valence Bond Method – Hydrogen Molecule Ion and Hydrogen Molecule as Examples.

MODULE II

Time Dependent Perturbation Theory – Transition Probability – Constant Perturbation – Harmonic Perturbation – Interaction of an Atom with an Electromagnetic Field – Induced Emission and Absorption – Dipole Approximation – Born Approximation and Scattering Amplitude.

Scattering: Scattering Cross Section and Scattering Amplitude – Low Energy Scattering by a Central Potential – Method of Partial Waves – Phase Shifts – Optical Theorem – Scattering by a Square Well Potential – The Born Approximation.

MODULE III

Relativistic Quantum Mechanics: Introduction – The First Order Wave Equations – Dirac Equations – Dirac Matrices – Solution of the Free Particle Dirac Equation – Spin of the Electron – Equation of Continuity – Non-relativistic Limit – Spin Orbit Coupling – Dirac Equation of Hydrogen Atom – Covariance of the Dirac Equation – Bilinear Covariants – The Hole Theory – The Weyl Equations for the Neutrino – The Second Order Wave Equations: The Klein-Gordon Equation – Wave Equation of the Photon – Charge Conjugation for Dirac and Klein-Gordon Equations – CPT Theorem.

MODULE IV

Quantization of Fields: Principles of Canonical Quantization of Fields – Lagrangian Density and Hamiltonian Density – Second Quantization of the Schrödinger Wave Field for Bosons and Fermions.

Textbooks:

1. V. K. Thankappan, Quantum Mechanics, Wiley Eastern.
2. Ghatak and Lokanathan, Quantum Mechanics, MacMillan.
3. Amit Goswami, Quantum Mechanics, Wm. C. Brown Publishers.
4. Bransden and Joachain, Introduction to Quantum Mechanics, ELBS.

References:

1. L. L. Schiff, Quantum Mechanics, McGraw Hill.
2. J. J. Sakurai, Modern Quantum Mechanics, Addison Wesley.
3. Powell and Crasemann, Quantum Mechanics, Addison Wesley.
4. Stephen Gasirowicz, Quantum Physics, Wiley Eastern.
5. A. Messiah, Quantum Mechanics, John Wiley & Sons.
6. Cohen Tannoubji, C. Diub and Laloe, Quantum Mechanics, Wiley Eastern.
7. Eugence Merzbacher, Quantum Mechanics.
8. P. A. M. Diarc, Principles of Quantum Mechanics.
9. S. N. Biswas, Quantum Mechanics.

MSPHY03E01: ATOMIC AND MOLECULAR SPECTROSCOPY

Objectives:

Spectroscopy is the study of the interaction between matter and electromagnetic radiation via atomic and molecular spectroscopy. This course provides an introductory idea to the postgraduate students about the spectra of hydrogen like atoms, alkali spectra and spectra of many electron systems. It also gives insightful knowledge about the changes in the spectra of different atoms in presence of an external field as well as the change in the energy levels of these atoms due to the different types of magnetic interactions. The present contents of this course also provide the basic physical properties like different types of spectra (electronic, rotational and vibration) of different molecules with different atoms. The main topics included in the course structure are atomic spectra, coupling schemes, normal Zeeman effect, anomalous Zeeman effect, Paschen-Back effect, rotation and vibration spectra of molecules, infrared spectroscopy, Raman spectroscopy, NMR spectroscopy, ESR spectroscopy etc.

Course Outcome

(i) The students will be able to know about the spectra of hydrogen like atoms, spectra of alkali metals, spectra of many electron systems.

(ii) Why the strong nuclear force is extreme and the range of the nuclear force is of the order of nuclear radius can be well understood by the students. The application of time energy uncertainty relation is made use of for the above purpose.

(iii) Provides the students with the knowledge of rotational and vibrational spectra of polyatomic, linear and symmetric top molecules.

(iv) The ability to apply the techniques of microwave and infrared spectroscopy to elucidate the structure of molecules can be achieved by the students.

(v) Students will be able to apply the principle of Raman spectroscopy and its applications

(vi) The basic working principle and applications of ESR, NMR, FTIR, and Mossbauer Spectroscopy can be understood by the students.

(vii) Able to calculate and draw the number of energy level splitting and its transition using selection rules in electrical and magnetic fields.

(viii) Able to understand the structure determination using IR and Raman Spectroscopy of molecules of type XY_2, XY_3 and XY_4.

(ix) Students will develop an ability to demonstrate the interaction Between Nuclear Spin and Magnetic Field with Larmour precession and resonance condition.

(x) The Students should be familiar with the basic knowledge of the NMR Spectrometer, application in medicine (MRI), principle of ESR, and principle of Mossbauer spectroscopy.

MODULE I

Spectra of Hydrogen Like Ions – Alkali Spectra – Many Electron Systems – L-S and j-j Coupling – Space Quantization – Stern-Gerlach Experiment – Zeeman Effect – Normal and

Anomalous Zeeman Effect – Lande-g Formula – Paschen-Back effect – Stark Effect – Hyperfine Structure of Spectral Lines.

MODULE II

Review of Rotation and Vibration Spectra – Breakdown of Born-Oppenheimer Approximation – Vibrations of Polyatomic Molecules – Rotational and Vibrational Spectra of Polyatomic Molecules – Linear and Symmetric Top Molecules – FTIR – Electronic Spectra of Diatomic Molecules – Vibrational Coarse Structure – Progressions – Franck-Condon Principle – Rotational Fine Structure of Electronic Vibrational Transitions – The Fortrat Diagram – Dissociation and Predissociation.

MODULE III

Classical Theory of Raman Effect – Pure Rotational Raman Spectra of Linear and Symmetric Top Molecules – Vibration Raman Spectra – Raman Activity of Vibrations – Rules of Mutual Exclusion – Example of H_2O and CO_2 – Vibration Raman Spectra of Symmetric Top Molecules – Structure Determination Using IR and Raman Spectroscopy – Molecules of type XY_2, XY_3 and XY_4.

MODULE IV

Interaction Between Nuclear Spin and Magnetic Field – Larmor Precession – Resonance Condition – Chemical Shift – Example of CH_3OH – NMR Spectrometer – Application in Medicine (MRI) – Principle of ESR – Principles of Mossbauer Spectroscopy – Doppler Shift – Mossbauer Spectrometer –Applications of Mossbauer Spectroscopy.

Textbooks:

1. B. P. Straughn & S. Walker, Spectroscopy-Vol. I& II, Chapman & Hall.
2. C. N. Banwell & E. M. Mc Cash, Fundamentals of Molecular Spectroscopy, TMH.
3. G. Herzberg, Molecular Spectra and Molecular Structure Vol I, II & III, VAN Nostrand Company.

References:

1. H. E. White, Introduction to Atomic Spectra, McGraw Hill.
2. G. Aruldas, Molecular Structure and Spectroscopy, Prentice Hall.

MSPHY03E02 MODERN OPTICS

Objective: The main objectives of the course to study theory, construction, working and different application of Lasers. Also, understanding the theory, construction, working and different application of optical fibbers. This course also covers nonlinear optical phenomena like second harmonic generation, parametric amplification, self-focusing etc. Another important objective of this course is detailed study of modern optics phenomena like multiple beam interference, different type of diffraction, optical activities and nanophotonics.

Course outcome

(i) Explain the basics of LASER.
(ii) Describe the construction and working of carbon dioxide lasers.
(iii) Discuss the applications of lasers.
(iv) Explain the propagation mechanism of light through optical fiber.
(v) Derive the relation between Numerical Aperture and Refractive indices.
(vi) Classify the types of optical fibers.
(vii) Explain the attenuation mechanisms
(viii) Details study regarding nonlinear optics
(ix) Understanding Harmonic generation, parametric amplification etc
(x) Understanding details regarding Nanophotonics

MODULE I

Lasers: Introduction – Properties of Lasers: Intensity, Monochromaticity, Directionality and Coherence – Einstein's Coefficients – Gain Coefficient – Concept of Population Inversion – Line Broadening Mechanisms: Natural, Collision and Doppler Broadening – Rate Equations: Three Level and Four Level Systems – Temporal Coherence and Spatial Coherence – Ruby Laser – Argon-Ion Laser – CO_2 Laser – Dye Laser – Semiconductor Laser – Spatial Frequency and Holography – Laser Induced Fusion.

MODULE II

Fibre Optics: Introduction – Fibre Optic Communication System – Advantages of Fibre-Optic Systems – Ray Propagation in Step-Index Fibres – Ray Propagation in Graded Index Fibres – Effect of Material Dispersion – The Combined Effect of Multipath and Material Dispersion – Calculation of rms Pulse Width –Single Mode Fibres (SMF) – Characteristic Parameters of SMFs – Dispersion in Single Mode Fibres.

MODULE III

Nonlinear Optics: Harmonic generation- second harmonic generation- phase matching-third harmonic generation- optical mixing-para magnetization of light- self focusing- multi quantum photoelectric effect- two photon process and theory-multi photon processes- three photon processes- second harmonic generation- parametric generation of light.

MODULE IV

Nanophotonics—An Exciting Frontier in Nanotechnology-Nanophotonics at a Glance-Foundations for Nanophotonics-Photons and Electrons: Similarities and Differences-Free-Space Propagation-Confinement of Photons and Electrons-Propagation Through a Classically Forbidden Zone: Tunnelling-Localization Under a Periodic Potential: Bandgap-Cooperative Effects for Photons and Electrons-Plasmonics-Metallic Nanoparticles and Nanorods-Metallic Nanoshells-Local Field Enhancement-Sub wavelength Aperture Plasmonics-Plasmonic Wave Guiding-Applications of Metallic Nanostructures-Photonic Crystals-Basics Concepts-Features of Photonic Crystals-Methods of Fabrication-Photonic Crystal Optical Circuitry-Photonic Crystal Fibers (PCF)- Photonic Crystal Sensors

Textbooks:

1. William Silfvast, Laser Fundamentals, Cambridge University.
2. G.R.Fowles, *Introduction to Modern Optics*, Second Edition, Dover Publications(1989)
3. A.Yariv, *Introduction to Opticalelectronics*, Holt, Reinhart and Winston(1976)
4. Laud B. B., Lasers and Non-Linear Optics, Wiley Eastern.
5. Ghatak and Thyagarajan, Optical Electronics, Cambridge.
6. R. P. Khare, Fibre Optics and Optoelectronics, Oxford University Press.
7. Paras N Prasad, Nanophotonics, Wiley Interscience

References:

1. J. T. Vadeyan, Laser Electronics, Prentice Hall of India.
2. Ghatak and Thyagarajan, Lasers: Theory and Applications, McMillan.
3. J. M. Senior, Optical Fiber Communications, Prentice Hall.
4. B. P. Pal, Fundamentals for Fiber Optics in Telecommunication, Wiley.
5. R. G. Husperger, Integrated Optics, Springer Verlag.

MSPHY03E03 SEMICONDUCTING MATERIALS AND DEVICES

Objectives: In the present era of electronic and optoelectronic devices, semiconductor materials play a significant role. So, the primary objective of this elective pater is to provide the students an understanding of basic and advanced properties of semiconductor materials as well as their functioning in some of the applications. Students will learn the physical behavior of bipolar junction transistors and field effect transistors by forming semiconductor junctions. Further, the principle and working of optoelectronic devices such as solar cells, photodetectors, light emitting diodes etc. will also be elaborated.

Outcomes:

(i) Understanding on the basic and advanced properties of semiconductor materials.

(ii) The importance of semiconductor materials in various device applications.

(iii) Working of bipolar junction transistors and field effect transistors on a semiconductor perspective.

(iv) Principle and working of optoelectronic devices such as solar cells, photodetectors, light emitting diodes etc.

MODULE I

Carrier Drift – Drift Current Density – Mobility Effects – Conductivity – Velocity Saturation – Carrier Diffusion – Diffusion Current Density – Total Current Density – Graded Impurity Distribution – Induced Electric Field – The Einstein Relation.

Reciprocal Lattice – Bragg Reflection of Electron Waves – Brillouin Zones – Important Features of Energy Bands of Si, Ge and GaAs (derivation not included).

MODULE II

Intrinsic, Extrinsic and Compound Semiconductors – Electrons and Holes – Semiconductor Statistics – Electron and Hole Mobilities and Drift Velocities – Hall Effect – Magneto resistance – Quasi Fermi Levels – Generation and Recombination of Carriers.

p-n Junction under Zero Bias Condition – Depletion Capacitance – Diffusion Capacitance – Tunneling and Tunnel Diodes – Junction Breakdown – Schottky Barriers – Ohmic Contacts.

MODULE III

Bipolar Junction Transistor: Principles of Operation – Doping Profile – Electron Diffusion Current in the Base – BJT as a Switch – Bipolar Transistors in Integrated Circuits.

FET: Basic Principles – Surface Charge in Metal Oxide Semiconductor Capacitors – MOSFET: Principles of Operation – Charge Coupled Devices – Advanced MOS Devices

MODULE IV

Crystalline Solar Cells – Conversion Efficiency – p-n Junction Solar Cells – Spectral Response – Equivalent Circuit – Amorphous Silicon Solar Cells – Photo Detectors – PIN Diode Detectors – Electroluminescence of Electromagnetic Waves in Two Level Systems – LEDs – Semiconductor Lasers: Optical Gain – Integrated Optoelectronics.

Textbooks:

1. Michael Shur, Physics of Semiconductor Devices, Prentice Hall of India, 1995.
2. Donald A. Neaman, Semiconductor Physics and Devices, Tata McGraw Hill.
3. Sze S. M., Physics of Semiconductor Devices, John Wiley & Sons, 1993.

References:

1. S. S. Islam, Semiconductor Physics and Devices, Oxford University Press.
2. Karl Hess, Advanced Theory of Semiconductor Devices, Prentice Hall of India.
3. Jasprit Singh, Semiconductor Devices: An Introduction, McGraw Hill, 1994.

MSPHY03C12 PRACTICAL – III MODERN PHYSICS

(At least 16 experiments should be done and preference to be given for material science experiments)

1. G.M counter – Plateau and statistics of counting, operating voltage and to verify the distribution law satisfied by the radioactive decay.
2. Absorption coefficient of "gamma" rays – To determine the absorption coefficient of a given material for CS 137 gamma rays using GM counter.
3. Absorption coefficient of "beta" rays – To determine the Absorption coefficient of a given material for beta ray source using GM counter.
4. Feather analysis – To determine the end point energy of beta particles from the given source by feather analysis method.
5. Scintillation Counter – To calibrate the given gamma ray (Scintillation) spectrometer using standard gamma ray source and to determine the energy of an unknown source.
6. Compton scattering – To verify the theoretical expression for the energy of the Compton scattered gamma rays at a given angle using a scintillation gamma spectrometer and to determine the rest mass energy of the electron.
7. Hydrogen spectrum – To photograph the spectrum and hence to determine the Rydberg constant.
8. Absorption spectrum of $KMnO_4$ – To photograph the absorption spectrum and to determine the wavelengths of the absorption band.
9. Absorption spectrum of Iodine – To photograph the iodine spectrum and to determine the dissociation energy.
10. Vibration bands of Al_2O_3 – To photograph the emission of Al_2O_3 spectrum and to identify the band heads.
11. Nuclear magnetic resonance – To determine g-factor.
12. Carbon arc – To photograph the emission spectrum and to identify the spectral lines of iron, copper and potassium.
13. Hall Effect in semiconductors – To determine the carrier concentration in the given specimen of semiconductor material.
14. Determination of band gap energy in silicon.
15. Determination of band gap energy in germanium.
16. Zener voltage characteristics at low and ambient temperatures – To study the variation of Zener voltage of a given diode with temperature.

17. Ultrasonic Interferometer – To determine the velocity of ultrasonic waves in the given liquids.
18. Thin films – To determine the electrical conductivity, reflectivity, sheet resistance and refractive index.
19. Thomson's experiment – To determine e/m ratio of an electron.
20. Optical fibre characteristics – To determine the numerical aperture, attenuation and bandwidth.
21. Frank Hertz experiment – To determine the ionization potential.
22. Four probe method – To study the bulk resistance and the band gap energy of the given semiconductor.
23. LED characteristics – Determination of wavelength of emission, current-voltage characteristics and variation with temperature, variation of output power with applied voltage etc.
24. Photoelectric effect – Determination of Planck's constant (White light and filters or LEDs of different colours may be used).
25. Growth of a single crystal from the solution and determination of their structural, electrical and optical properties.
26. Study of colour centers – Thermo luminescence and glow curves.
27. Ionic conductivity in KCl and NaCl crystals.
28. Strain gauge – Y of a metal beam.
29. Solar cell – Spectral response and I-V characteristics.
30. Dielectric constant of a liquid by LCR Bridge.
31. Study of junction capacitance with voltage of P-N junction (Si, Ge and GaAs)
32. Michelson Interferometer – Determination of I1 and I2 of sodium light.
33. Michelson interferometer – Determination of thickness of a mica sheet.
34. Thermo luminescence spectra of Alkali halides.
35. Variation of dielectric constant with temperature of a Ferro electric material (Barium titanate).
36. Ferrite specimen – Variation of magnetic properties with composition.
37. Advanced Laser Experiments – Experiments with Hologram.
38. Zeeman Effect – To study the Zeeman splitting of the green mercury line using Fabry Perot etalon for the normal transverse and longitudinal configuration.
39. X ray Apparatus – To study diffraction of X rays.

SEMESTER IV

MSPHY04C14: STATISTICAL MECHANICS

Objectives: Statistical mechanism is a formalism which aims at explaining the physical properties of matter in bulk on the basis of the dynamical behavior of its microscopic constituents. The formalism is almost as unlimited as the very range of the natural phenomena. This paper is aiming to make understand some of the previously studied thermodynamic phenomena in terms of the microscopic parameters by using the statistical mechanics tool. The paper begins with bridging macroscopic and microscopic worlds and after that introduces ensemble formalism. After that the basic ideas of quantum statistical mechanics and fundamentals of Ising theory will be studied.

Outcomes:

(i) The main outcome of this course is to understand and explain the macroscopic phenomena (any natural phenomena) in terms of the microscopic parameters or to bridge the microscopic and macroscopic worlds.

(ii) Able to know the ensemble formalism and differentiate micro canonical, canonical and grand canonical ensembles.

(iii) As a part of the course classical and quantum statistical mechanics will be studied.

(iv) Learn how a complete theoretical model named Ising model explains the phase transition phenomena.

MODULE I

The Macroscopic and Microscopic States – Contact Between Thermodynamics and Statistics – Classical Ideal Gas – Gibbs Paradox – Phase Space – Liouville's Theorem.

MODULE II

Ensembles: Micro Canonical Ensemble – Quantization of Phase Space – Canonical Ensemble: Equilibrium Between System and Reservoir – Boltzmann distribution – Physical Significance of Statistical Quantities – Classical Systems – Energy Fluctuations – Equipartition Theorem and Virial Theorem – Grand Canonical Ensemble: Equilibrium

Between System and Reservoir – Gibbs distribution – Significance of Statistical Quantities – Energy and Density Fluctuations.

MODULE III

Density Operator – Statistics of Various Ensembles – Ideal Gas in a Quantum Mechanical Micro Canonical Ensemble.

Behavior of Ideal Bose Gas – Bose-Einstein Condensation – Planck's Theory of Blackbody Radiation – Debye Theory of Specific Heat.

MODULE IV

Behavior of an Ideal Fermi Gas – Fermi Temperature and Fermi Energy – Electron Gas in Metals – Landau diamagnetism – de Hass van Alphen Effect – Temperature Dependent Specific Heat of Metals – Statistical Equilibrium of White Dwarfs.

Dynamical Model of Phase Transitions – Definition of Ising Model – The Lattice Gas and Binary Alloy – Ising Model in the Zeroth and First Approximation – Critical Exponents – Ising Model in One Dimension.

Textbook:

1. R. K. Pathria, Statistical Mechanics, Butterworth Heinemann.

References:

1. Kerson Huang, Statistical Mechanics, John Wiley & Sons.
2. Landau & Lifeshitz, Statistical Physics, Pergman.
3. F. Reif, Fundamentals of Statistical and Thermal Physics, McGraw Hill.

MSPHY04E04 PARTICLE AND ASTROPHYSICS

Objectives: The course on particle physics gives a modern explanation of theory and matter that we encounter every day. The theory developed with the classification of forces exists in nature. The modern explanation of the strong nuclear force was proposed by Yukawa. The concept of modern quantum numbers like baryon, strangeness, isospin, the third component of isospin etc are well explained apart from the classical quantum numbers like energy, angular momentum, linear momentum and charge. Quark model developed by Gell-Mann which considers quark as the fundamental building block for the atoms. Even Though the lack of experimental evidence for the existence of quark is there, still most of the phenomenon associated with the atom is very well explained using the quark model. Astrophysics course on the other hand gives a detailed description of the evolution of the stars, big bann theory and the hartward system of the classification of the stars is very well explained. The concepts like formation of protostars, derivation of the Chandrasekhar limit and the theory about back holes are also the objectives of this course.

Course Outcome

(i) Why the strong nuclear force is extremely strong and the range of nuclear force is of the order of nuclear radius is very well understood by the students according to Yukawa's proposal. How the Heisenberg uncertainty relations connecting energy and time is used to deduce the range of nuclear force is very well explained.

(ii) The concept of resonance or extremely short lived particles or resonance particles and the detection of the resonance particles using resonance production experiment and the resonance formation experiment is well understood by the students.

(iii) Apart from the classical quantum numbers like energy, linear momentum, angular momentum and the electric charge, the students well acquainted with quantum numbers like baryon, strangeness, isospin, third components of isospin etc.

(iv) The explanation of quarks is the fundamental building block for the atoms which has the unique property of non-integral charge is the important outcome of the course. This concept helps the students give a correct explanation of the different quantum numbers associated with the elementary particles.

(v) The absolute and apparent magnitudes, the Harvard model of the classification of the stars and the Hertzsprung – Russel Diagram for the representation of the stars are other outcomes of the course.

(vi) Students also get familiarize with the concepts like interstellar gas, the cooling of the white dwarf, neutron stars and the formation and the detection of the black holes are also the important outcomes.

MODULE I

Strong and Weak Nuclear Forces – Yukawa's Proposal – Production, Properties and Modes of Decay of Pions and Muons – The Muon – The Real Pion – Isotopic Spin – Strange Particles – Gell Mann-Nishijima Formula – Extremely Short Lived Particles – Resonances and Their Quantum Numbers with Special Reference to Pions – Nucleon Scattering.

Conservation Laws – Intrinsic Quantum Numbers Associated with Elementary Particles – Theory of Weak Interaction – Parity Non-conservation – The TCP Theorem – Unification of Weak Electromagnetic Interaction – The Glashow-Weinberg-Salam Model.

MODULE II

Quark Model – The Sakata Model – The Eight-Fold way – GellMann-Okubo and Coleman-Glashow Equations – Quarks and Quark Models – Different Types – The Confined Quarks – Experimental Evidence for the Existence of Quarks – Coloured Quarks – Charm, Truth and Beauty.

MODULE III

Absolute Magnitude and Distance Modulus – Colour Index of Stars – Luminosities of Stars – Stellar Parallax – Units of Stellar Distance – Celestial Sphere and Celestial Coordinate Systems – Harward System of Classification of Stars – Spectroscopic Parallax – The Hertzsprung – Russel Diagram.

MODULE IV

Interstellar Dust and Gas – The Formation of ProtoStars – Pre-main Sequence: Evolution – Evolution of the Main Sequence – Late Stages of Degenerate Matter – The Chandrasekhar Limit – The Cooling of White Dwarfs – Neutron Stars – Pulsars – Quasars – Black Holes. Comets, Asteroids and Meteorites – The Formation of the Solar System.

Textbooks:

1. G. D. Coughlan and J. E. Dodd, The Ideas of Particle Physics, Cambridge University Press, 1991.

2. Yuval Ne'eman and Yoram Kirsh, Particle Hunters, Cambridge University Press, 1996.
3. David Griffith, Introduction to Elementary Particle Physics, John Wiley & Sons.
4. M. P. Khanna, Introduction to Particle Physics, Prentice Hall of India.
5. Bardley W. Carrol & Dale A. Ostile, An Introduction to Modern Astrophysics, Addison Wesley.
6. Baidyanath Basu, An Introduction to Modern Astrophysics, Prentice Hall of India.

References:

1. Narlikar J. V. and Ajith K. Kembhavi, Quasars and Active Galactic Nuclei.
2. Narlikar J. V., Introduction to Cosmology.
3. Sinha B. C., Srivastava D. K., Viyogi Y. P., Physics and Astrophysics of Quark-Gluon, Narosa Publishing House, New Delhi.
4. Hughes, Elementary Particles – 2nd Edition, Cambridge University Press.

MSPHY04E05 THIN FILM TECHNOLOGY

Objective: The main objectives of the course are to study theory of thin film formation and various factors to affect the structure of thin films. Next is an expertzing different thin film fabrication and characterization technique. This course also covers important properties and application of thin films

Course outcome

(i) Explain the basics of thin films.
(ii) Describe the important theory of thin film formation.
(iii) Discuss the various factors affecting the structure of thin films.
(iv) Explain the different techniques for thin film fabrication like vacuum evaporation, pulsed laser ablation, sputtering, chemical vapor deposition etc
(v) Understanding how to measure the thickness of thin films.
(vi) Classify the different characterization techniques like XRD, Uv-Vis spectroscopy, SEM, TEM etc and study its theory, construction and working in detail.
(vii) Explain the attenuation mechanisms
(viii) Understanding different applications of thin films in technology and daily life.

MODULE I

Thin Film Physics: Mechanism of Thin Film Formation – Formation Stages of Thin Films – Condensation and Nucleation – Thermodynamic Theory of Nucleation – Growth and Coalescence of Islands – Influence of Various Factors on the Final Structure of Thin Films – Crystallographic Structure of Thin Films.

MODULE II

Methods of Preparation/Synthesis of Thin Films: Vacuum Evaporation: Resistive Heating, Electron Beam Evaporation and Laser Beam Evaporation – Sputtering: Glow Discharge, Radio Frequency and Magnetron Sputtering – Chemical Methods: LCVD, PCVD and PECVD – Spray Method: Spray Hydrolysis and Spray Pyrolysis – Langmuir Blochet Technique – Sol-gel Deposition.

Thickness Measurements: Resistance, Capacitance, Microbalance, Quartz Crystal Thickness Monitor, Optical Absorption, Multiple Beam Interference, Interference Colour and Ellipsometry Methods.

MODULE III

Optical Properties of Thin Films: Reflection and Transmission at an Interface – Reflection and Transmission by a Single Film – Optical Constants and Their Measurement Techniques – Reflectivity Variation with Thickness – Antireflection Coatings: Single and Multilayer – Reflection Coatings – Interference Filters.

Electrical Properties of Metallic Thin Films: Sources of Resistivity – Sheet Resistance – TCR – Theories of Size Effect – Theory of Conduction in Discontinuous Films.

Dielectric Properties: Simple Electrical Theory – DC Conduction Mechanism – AC Conduction Mechanism.

MODULE IV

Characterization/Analysis of Materials and Devices (Basic Principles): X-Ray Diffraction (XRD) – Transmission Electron Microscopy (TEM) – Scanning Electron Microscopy (SEM) – Energy Dispersive Analysis of X-rays (EDAX) – UV-VIS Spectroscopy – Fourier Transform Infrared (FTIR) Spectroscopy – Electron Spin Resonance (ESR) – X-ray

Photoelectron Spectroscopy (XPS) – Scanning Tunneling Microscopy (STM) – Atomic Force Microscopy (AFM).

Applications: Thin film resistors: Materials and Design of thin film resistors (Choice of resistor and shape and area) – Trimming of Thin Film resistors – Sheet Resistance Control – Individual Resistor Trimming – Thin Film Capacitors – Thin Film Field Transistors – Fabrication and Characteristics – Thin Film Diodes.

Textbooks:

1. Maisel L. I. and Glang R., HandBook of Thin Film Technology, McGraw Hill, 1970.
2. Chopra K. L., Thin Film Phenomena, McGraw Hill, 1969.
3. Goswami A., Thin Film Fundamentals, New Age International Ltd., 1996.
4. Joy George, Preparation of Thin Films, Dekker.
5. Khangaonkar P. R., An Introduction to Materials Characterization, Pen ram International Publishing.

References:

1. Donald L. Smith, Thin Film Deposition: Principles and Practice, McGraw Hill, Singapore, 2001.
2. Holland L., Vacuum Deposition of Thin Films, Chapman and Hall, 1956.
3. Heavens O. S., Thin Film Physics, Butterworth Scientific Publication, 1955.
4. Berry R. W. and Others, Thin Film Technology, McGraw Hill, 1970.
5. Rao V. V., Ghosh T. B., Chopra K. L., Vacuum Science and Technology, Allied Publication, 1998.
6. Guthrie A., Vacuum Technology, John Wiley & Sons, 1963.

MSPHY04O01 PHOTOVOLTAIC ENERGY CONVERSION

Objectives: The main objective of this paper is to introduce the details of one of the renewable energy sources - Solar cells. It will provide the basic principle of solar cells and the various parameters and the design conditions which significantly affect the efficiency of solar cells. Also, the features of thin film solar cell technology as well as thin film solar cell technology based on different thin film materials such as cadmium telluride, amorphous silicon etc. will be learned. Also, this paper will introduce research oriented concepts like

Solar Photovoltaic (SPV) Modules, Series and Parallel Connections, mismatch in connection etc.

Outcomes:

(i) Detailed study of solar cells and characteristics
(ii) Design criteria of solar cells parameters
(iii) Thin film solar cell technologies
(iv) Amorphous Si Solar Cell Technology
(v) Cadmium Telluride Solar Cell Technology
(vi) Solar Photovoltaic Applications: Solar Photovoltaic (SPV) Modules

MODULE I

Solar Energy – The Solar Constant – Solar Intensity on Earth's Surface – Direct and Diffuse Radiation – Apparent Motion of Sun – Solar Insolation Data.

MODULE II

p-n Junction I-V Relation: Quantitative Analysis – p-n Junction under Illumination: Generation of Photo Voltage(PV) and Light Generated Current – I-V Equation for Solar Cells – Solar Cell Characteristics.

Design of Solar Cells: Upper Limit of Solar Cell Parameters: Short Circuit Current, Open Circuit Voltage, Fill Factor and Efficiency – Losses in Solar Cells – Model of Solar Cells – Effect of Series and Shunt Resistance – Solar Radiation and Effect of Temperature on Solar Cell Efficiency – Solar Cell Design – Design for High Short Circuit Current – Choice of Junction Depth and Orientation – Minimization of Optical Losses and Recombination – Design for High Open Circuit Voltage – Design for High Fill Factor.

MODULE III

Thin Film Solar Cell Technologies: Generic Advantages of Thin Film Technologies – Materials for Thin Film Technologies – Thin Film Deposition Techniques – Common Features of Thin Film Technology – Amorphous Si Solar Cell Technology – Cadmium Telluride Solar Cell Technology – Thin Film Crystalline Solar Cells.

MODULE IV

Solar Photovoltaic Applications: Solar Photovoltaic (SPV) Modules – SPV from Solar Cells – Series and Parallel Connections – Mismatch in Cell Module – Mismatch in Series Connection – Hot Spots in Modules – Bypass Diode – Mismatch in Parallel Connection – Design and Structure of PV Modules – Number of Solar Cells – Wattage of Modules – PV Module Power Output – I-V Equation for PV Modules – I-V and Power Curves of Module – Effect of Solar Irradiation and Temperature.

Textbooks:

1. S. P. Sukhatme, Solar Energy, Tata McGraw Hill.
2. Chetan Singh Solanki, Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI, 2nd Edn, PHI, 2nd Edn.

References:

1. G. Busch and Schade, Lectures on Solid State Physics, Pergamon Press.
2. B. O. Seraphin, Solar energy conversion, Springer.
3. S. R. Das and K. L. Chopra, Thin Film Solar Cells, Springer.
4. Harold J. Hovel, Semiconductors and Semimetals-Vol.II, Academic Press.
5. Martin A. Green, Solar Cells, Prentice Hall Series.
6. Tom Markvart and Luis Castner, Handbook of Solar Cells, Springer.

MSPHY04O02 NANOSCIENCE AND TECHNOLOGY

Objective

This course is mainly designed for students from science backgrounds other than Physics. Main aim of the course is to provide basic knowledge of Nanoscience and related fields. Besides, to make the students acquire an awareness of Nanoscience and Applications. Finally, it is intended to help them understand a broad outline of Nanoscience and Nanotechnology.

Course outcome

Upon successful completion of this course students should be able to:

(i) Explain methods of fabricating nanostructures.

(ii) Describe different carbon based nanostructures

(iii) Relate the unique properties of nanomaterials to the reduced dimensionality of the material.
(iv) Describe tools for properties of nanostructures.

MODULE I

Preparation of quantum nanostructures: - size and dimensionality effects - size effects - potential wells - partial confinement - conduction electrons and dimensionality - Fermi gas and density of states - properties dependent on density of states - excitons - single-electron tunneling - applications - infrared detectors - quantum dot lasers - superconductivity. Microelectromechanical Systems (MEMS) - Nanoelectromechanical Systems (NEMS) – Fabrication of nanodevices and nanomachines - Molecular and Supramolecular Switches.

MODULE II

Carbon Nanostructures: Carbon Molecules - Nature of the Carbon Bond - New Carbon Structures - Carbon Clusters -Small Carbon Clusters - Carbon Nanotubes - Fabrication - Structure – Electrical Properties - Vibrational Properties – Mechanical Properties - Applications of Carbon Nanotubes - Computers - Fuel Cells - Chemical Sensors - Catalysis – Mechanical Reinforcement - Field Emission and Shielding. Solid Disordered Nanostructures - Methods of Synthesis - Failure Mechanisms of Conventional Grain Sized Materials – Mechanical Properties – Nano structured Multilayers -Electrical Properties – Porous Silicon - Metal Nano cluster - Composite Glasses

MODULE III

Synthesis of Nanomaterials: Top-down techniques: photolithography, other optical lithography (EUV, X-ray, LIL), particle-beam lithography (e-beam, focused ion beam, shadow mask evaporation), probe lithography, Bottom-up techniques: self-assembly, self-assembled monolayers, directed assembly, layer-by-layer assembly. Combination of Top-Down and Bottom-up techniques: current state-of-the-art. Pattern replication techniques: soft lithography, nano imprint lithography. Pattern transfer and enhancement techniques: dry etching, wet etching, pattern growth techniques (polymerization, directed assembly).

MODULE IV

Characterization techniques: Microscopy - Electron microscopy – Principles and instrumentation – resolution limit–scanning tunnelling microscopy – principles – scanning tunnelling microscope - SEM & TEM. Atomic force microscope–Instrumentation IR spectrophotometers–Theory and Instrumentation- Applications. Fourier 35 transform techniques – FTIR principles and instrumentation. Raman spectroscopy –Principles, Instrumentation and Applications. Microwave Spectroscopy - Instrumentation and Applications

Reference Books:

1. Introduction to Nanotechnology, Charles P. Poole, Jr. and Frank J. Owens, Wiley, (2003)
2. MEMS/NEMS: micro electro mechanical systems/nano electro mechanical systems Volume 1, Design Methods, Cornelius T. Leondes, Springer, (2006).
3. Instrumental methods of Chemical Analysis, G. Chatwal & Sham Anand, Himalaya
4. Introduction to Infrared and Raman spectroscopy, Norman D Colthup, Lawrence H Daly and Stephen E Wiberley, Academic press, NY.
5. Instrumental methods of analysis, H.H. Willard, L.L. Merrit, J.A. Dean & F.A. Settle, CBS Pub.
2. Principles of Instrumental analysis, Skoog and West – Hall – Sanders Int.
3. Instrumental methods of chemical analysis, G W Ewing, MGH 8. Scanning Tunnelling Microscopy, R. Wiesendanger & H.J. Guntherodt, Springer

MSPHY04O03 ENERGY PHYSICS

Objective

This course is mainly designed for students from any backgrounds such as science, arts, commerce etc. Main aim of the course is to provide basic knowledge on Energy resources and the need for conservation of energy. Besides, to make the students acquire an awareness of Solar energy, solar energy conversion and importance of solar energy in the present scenario. Finally, it is intended to help them grasp a broad outline of different energy sources like ocean energy, wind energy etc.

Course Outcomes:

(i) Understand Energy policy perspectives.
(ii) Classify technologies for conversion of solar energy resources.
(iii) Illustrate Photovoltaic conversion mechanism.
(iv) Make use of wind energy conversion.
(v) Explore various modes for ocean energy conversion.

MODULE I

Overview of world energy scenario; Energy Demand- present and future energy requirements; Review of conventional energy resources- Coal, gas and oil reserves, Tar sands and Oil Shale, Nuclear energy; Global warming; Green House Gas emissions, impacts, mitigation; sustainability; United Nations Framework Convention on Climate Change (UNFCCC); Sustainable development; Kyoto Protocol; Conference of Parties (COP); Clean Development Mechanism (CDM); Prototype Carbon Fund (PCF).

MODULE II

Solar Energy -Solar radiation, its measurements and prediction; Solar thermal collectors- flat plate collectors, concentrating collectors; solar heating of buildings; solar still; solar water heaters; solar dryers; conversion of heat energy in to mechanical energy, solar thermal power generation systems;

Photovoltaic Conversion -Intrinsic, extrinsic and compound semiconductor; Absorption of light; Recombination process; p-n junction: homo and hetero junctions; Dark and illumination characteristics; Principle of photovoltaic conversion of solar energy, Figure of merits of solar cell; Efficiency limits;

MODULE III

Wind Energy -Wind energy conversion principles; General introduction; Power, torque and speed characteristics. Atmospheric circulations; factors influencing wind, wind shear, turbulence, wind speed monitoring; Betz limit; Types and classification of WECS, characteristics and applications.

MODULE IV

Ocean Energy - Ocean energy resources, ocean energy routes; Principles of ocean thermal energy conversion systems; ocean thermal power plants; Principles of ocean wave energy conversion and tidal energy conversion.

Reference Books:

1. Non- conventional energy resources, B H Khan, Tata McGraw-Hill Publication 2006, ISBN 0-07-060654-4
2. Renewable Energy Resources Paperback John Twidell and Tony Weir, Routledge, Taylor& Francis, 2015 ISBN 9780415584388
3. Solar Photovoltaics: Fundamentals, Technologies And Applications, Chetan Singh Solanki, PHI Learning Pvt. Ltd., Third Edition 2015, ISBN 978-81-203-5111-0
4. Non-Conventional Energy Resources: G. D. Rai, Khanna Publishers,2008.
5. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.
6. Renewable Energy, Bent Sorensen (2nd Ed), Academic press, New York, 2000

M.Sc. PHYSICS (Advanced Materials)

Model Question Paper (2020 Admission onwards)

Semester: 1

MSPHY01C04: ELECTRONICS

Time: 3 hours **Maximum Marks: 60**

Part A
Answer any five questions; each question carries 3 marks

Answer **any five** questions. Each question carries **3** marks.

1. List any four OP-AMP parameters and explain their significance in circuit applications.
2. Sketch the basic OP-AMP integrator circuit. Derive an expression for the output of the circuit.
3. Explain the design considerations of a 2^{nd} order band reject filter. Plot the frequency response.
4. Draw the block diagram of a M/S J-K flip flop. Give the truth table and explain the working.
5. Construct the truth table of a mod 8 ripple counters. Draw the timing diagram. What would be the output state after the arrival of 7th clock pulse if the counter was initially preset?
6. Explain the internal register structure of Intel 8085.

(5×3 = 15)

Part B

Answer any three; each question carries 5 marks

7. An OP-AMP is rated with differential voltage gain equal to 4000 and CMRR equal to 80 db. Calculate the output when both inputs are driven by the same signal of amplitude 100 mV.
8. Design a differentiator to differentiate an input signal that varies in the frequency range of 100 Hz to 10kHz. If a sine wave of 1V peak at 1kHz is applied to the above differentiator, draw its output waveform.

9. Determine the number of flip-flops needed to construct a shift register capable of storing (a) a 6 bit binary number (b) decimal number upto 32 and (c) hexadecimal number upto F.
10. A small one byte number is stored at memory location 2000 H. Write an assembly language program for Intel 8085 to store the number one less than this at the previous location and one greater than this at the next location.
11. Design a second order band pass Butterworth filter with lower cut off frequency of 5 kHz and higher cutoff as 15 kHz

(3×5 = 15)

Part C

Answer any three questions; each question carries 10 marks

12. Explain the working of OP-AMP as a voltage comparator and Schmitt trigger.
13. Explain with circuit diagram the working of a typical shift register. Discuss about different types of registers giving examples. Give an account of applications of shift registers.
14. Discuss microprocessor communication and bus timings and bus structure with reference to 8085 microprocessor.
15. With the help of a block diagram explain functioning of simultaneous conversion A/D converter. How does it differ with other A/D converters?
16. Design a four bit synchronous up-down counter and draw the waveforms. Explain the role of each gate used.

(3 x 10 =30)