THIRUVALLUVAR UNIVERSITY

SERKKADU, VELLORE – 632 115

DEPARTMENT OF PHYSICS

MASTER OF SCIENCE IN PHYSICS

[Under Choice Based Credit System (CBCS)]

W.e.f the academic year 2020-2021

SYLLABUS AND REGULATIONS

FOR UNIVERSITY DEPARTMENT

திருவள்ளுவர் பல்கலைக்கழகம்

THIRUVALLUVAR UNIVERSITY

MASTER OF SCIENCE DEGREE COURSE

M.Sc. PHYSICS

REGULATIONS
CBCS PATTERN

With effect from 2020-2021

Definitions:

Programme **:**"Programme" means a course of study leading to the award of a degree in a discipline.

Course **:** "Course" refers to a paper / practical / subject offered under the degreeprogramme.
Each Course is to be designed variously under lectures / tutorials / laboratory or field work / seminar / practical training / Assignments / Term paper or Report writing etc., to meet effective teaching and learning needs.

i) Core Courses:
"The Core Courses" related to the programme concerned including practicals offered in the programme".

ii) Elective Courses:
"Elective courses" related to the core courses of the programme concerned, offered in the programme".

A detailed explanation of the above with relevant credits are given under **"Scheme of Examination along with Distribution of Marks and Credits"**

Duration **:**This means the stipulated years of study to complete a programme as prescribed by the University from time to time. Currently for the postgraduate programme the duration of study is TWO years. These regulations shall apply to the regular course of study in approved institutions of the University.

Credits **:**The weightage given to each course of study (subject) by the experts of the Board of Studies concerned.

The term 'Credit' refers to the weightage given to a course, usually in relation to the instructional hours assigned to it. For instance, a six hour course per week is assigned 6/5/4 credits, a five hour course per week is assigned 5/4/3 credits and a four hour course per week is given 4/3/2 credits. However, in no instance the credits of a course can be greater than the hours allotted to it.

The total minimum credits, required for completing a PG program is 90.

Credit System **:**The course of study under this regulation, where weightage of credits are spread over to different semesters during the period of study and the Cumulative Grade Point Average shall be awarded based on the credits earned by the students. A total of 90 credits are prescribed for the Postgraduate Programme offered in two years.

Choice Based :All PostgraduateProgrammesoffered by the University shall be under Choice Based Credit System.

Choice Based Credit System (CBCS):This is to enhance the quality and mobility of the students within and between the Universities in the country and abroad.

1. **Eligibility for Admission to the Course:**

A candidate who have passed the B.Sc. Degree Examination in Physics of this University or an Examination of any other University equivalent to Physics/Applied Physics with Mathematics and chemistry as allied subjects accepted by the Syndicate as equivalent thereto shall be permitted to appear and qualify for the Master of Science (M.Sc.) Degree Examination of this University after a Course of two academic years in the University Department / Colleges affiliated to this University.

No student shall be eligible for admission to a Master's degree programme in any of the faculties unless he/she has successfully completed a three year undergraduate degree or earned prescribed number of credits for an undergraduate degree through the examinations conducted by a University / autonomous institution or possesses such qualifications recognized by the Thiruvalluvar University as equivalent to an undergraduate degree. Provided that candidates for admission into the specific main subject of study shall also possess **such other qualifying conditions as may be prescribed by the University in the Regulations** governing respective courses of study.

2. **Duration of the Course:**

The course shall extend over a period of **two years comprising** of four semesters with twosemestersin one academic year. There shall not be less than 90 working days for each semester. Examination shall be conducted at the end of every semester for the respective subjects.

Each semester have 90 working days consists of 5 teaching hours per working day.Thus,each semester has 450 teaching hours and the whole programme has 1800 teaching hours.The odd semesters shall consist of the period from July to November and the evensemesters from December to April.

3. **Course of Study:**

The course of study for MastersDegree Course in Physicsshall consistof Core, Elective subjects, Softskil, Internship, a Compulsory subject (Human Rights) and a Project in the fourth semester.

4. Distribution of Credit Points and Marks:

The Minimum Credit Requirement for a two yearMaster's programme shall be 94 (ninety) Credits. The break-up of credits for theprogramme is as follows:

(a).	Core Courses	:	70credits
(b).	Elective Courses	:	12 credits
(c).	Open Elective Courses	:	4 credits
(d).	Compulsory course	:	2 credits
(e)	Value Added course	:	2 credits
(f)	MOOC Courses	:	2 credits
(g)	Internship	:	2 credits

5. Continuous Internal Assessment Test:

The following assessment procedure will be followed for awarding the internal marksin theevaluation of the student's performances. Thebest 2 CIA test marks out of 3 CIA tests marks, will be taken for awarding the internal marks.

(a).	CIA Test Marks	:	15 marks.
(b).	Seminar	:	5 marks.
(c).	Assignment	:	5 marks
	Total	**:**	**25 marks**

6. Requirement toappear for the examinations

a) A candidate shall be permitted to appear for the university examinations for any semester (theory as well as practical) if

i. He/she secures **not less than 75%** of attendance in theory as well as inpracticals (separate attendance registers shall be maintained for theory and practical) in the number of working days during the semester.

ii. In the case of married woman candidates the minimum attendance requirement shall be not less than 55% of the total instructional days in theory as well as in practical.

iii. His/her conduct shall be satisfactory. Provided that it shall be open to the Syndicate, or any authority delegated with such powers by the Syndicate, to grant exemption to a candidate who has failed to earn 75% of the attendance in theory as well as in practical, prescribed, for valid reasons, subject to usual conditions.

b) A candidate who has secured **less than 75% but 65%** and above attendance in any semester separately for theory and practical, shall be permitted to take the examination on the recommendations of the Head of the Department to condone the lack of attendance on the payment of prescribed fees to the University, separately for theory and practical.

c) A candidate who has secured **less than 65% but 55%** and above attendance in any semester in theory as well as in practical, has to compensate the shortage in attendance in the subsequent semester (in the next year) besides earning the required percentage of attendance in that semester and appear for both semester papers together at the end of the later semester, on the payment of prescribed fees to the University, separately for theory and practical. However, shortage of attendance in I-semester shall be compensated while studying in III semester, shortage of attendance in II-semester shall be compensated while studying in IV semester, shortage of attendance in III&IV-semesters shall be compensated after rejoining the course in the 3rdyear. Also, separate attendance registers shall be maintained in theory as well as practical, for compensating the shortage of attendance. During the hours of compensation of attendance, the candidate shall not be given attendance for the regular semester classes.

d) A candidate who has secured **less than 55%** of attendance in any semester separately for theory and practical shall not be permitted to appear for the regular examinations in that particular semester or in subsequent semesters. He/she has to rejoin/ re-do the semester in which the attendance is less than 55%, on the payment of prescribed fees to the University, separately for theory and practical, after getting prior approval of the University.

e) A candidate who has secured **less than 65%** of attendance in the final semester separately for theory and practical, has to compensate his/her attendance shortage in a manner as decided by the concerned Head of the department, after getting prior approval of the University. The candidate shall be permitted to rejoin in the 4thsemester, after completing his/her regular 2 year course.

7. Scheme of Examination:

a. Any theory examination is conducted only for 3 hours irrespective of total marks allotted for the examinations.

b. There shall be theory examinations at the end of each semester, for odd semesters in the month of October / November; for even semesters in April / May. However, there shall be practical examinations at the end of even semesters in general, with exceptions in a few courses as prescribed by the Boards of studies, concerned. A candidate who does not pass the examination in any course(s) shall be permitted to appear in such failed course(s) in the subsequent examinations to be held in October / November or April / May.

c. All candidates admitted in first year, should get registered for the first semester examination, compulsorily. If registration is not possible owing to any reason including shortage of attendance beyond condonation limit, belated joining or on medical grounds, the candidates are permitted to rejoin the course in the next year.

8. Restrictions toappear for the examinations:

Any candidate having arrear paper(s) shall have the option to appear in any arrear paper along with the regular semester papers, in theory as well as in practical, as long as the transitory provision is applicable.

9.Medium ofInstruction and Examinations:

The mediumof instruction for the courses is English only.

10. Question Paper Pattern

The Question Paper Pattern for the University theory examinations is as follows:

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

Part – A (10×2 = 20 marks)
Answer ALL Questions

(Two Questionsfrom each unit)

Part – B (5× 5= 25 marks)
Answer ALL Questions
(Two Questions from each unit with internal Choice [either or type])

Part – C (3× 10= 30 marks)
Answer any Three Questions out of Five Questions

(One Question from each unit)

11. Passing Minimum

a). A candidate shall be declared to have passed the whole examination, if the candidate passes in all the theory papers and practical wherever prescribed as per the scheme of examinations by earning 90 credits in Core and Elective courses, including practical.

b). A candidate should get **not less than 50% in the University (external)** Examination, compulsorily, in all papers, including practical.Also the candidate who secures **not less than** 50% marks in the external as well as internal (CIA) examinations put together in any paper / practical shall be declared to have successfully passed the examination in the subject in theory as well as practical. There shall be no passing minimum for the CIA. The candidate, who absents himself for CIA programmes,even after a repeated chance, will be awarded zero mark in the concerned subject (zero to 25 for theory and zero to 40 for practical).

12. Distribution of Marks:

The following are the distribution of marks for external and internal for University (external) examination and continuous internal assessment and passing minimum marks for **theory papers of PG programmes**.

Table – 1(A)

Uni.Exam Total(ESE)	Passing Minimum For Uni.Exam	CIA Total	Passing Minimum For CIA	Total Marks Allotted	Passing Minimum (Uni.Exam+CIA)
75	38	25	0	100	50

The following are the Distribution of marks for the Continuous Internal Assessment in the theory papers of PG Programmes.

Table – 1(B):

S. No.	Theory	Distribution of Marks	
		Assignments	Tests
1.	Assignment - 1 (First 2 Units of the Syllabus)	10	---
2.	Test – 1 (First 2 Units of the Syllabus for 1 hour duration)	---	50
3.	Assignment - 2 (3rd& 4th Units of the Syllabus)	10	---
4.	Test – 2 (First 4 Units of the Syllabus for 2 hours duration)	---	50
5.	Seminar (Entire Syllabus)	10	---
6.	Test – 3 (Entire Syllabus for 3 hours duration)	---	100
Total Marks		**30**	**200**
Marks to be converted to		**5**	**20**
Total Maximum Marks for CIA		**25**	

13. Grading:

Once the marks of the CIA and end-semester examinations for each of the course are available, they shall be added. The mark thus obtained shall then be converted to the relevant letter grade, grade point as per the details given below:

Conversion of Marks to Grade Points and Letter Grade (Performance in a Course/Paper)

RANGE OF MARKS	GRADE POINTS	LETTER GRADE	DESCRIPTION
90-100	**9.0-10.0**	**O**	Outstanding
80-89	**8.0-8.9**	**D+**	Distinction
75-79	**7.5-7.9**	**D**	
70-74	**7.0-7.4**	**A+**	First Class
60-69	**6.0-6.9**	**A**	
50-59	**5.0-5.9**	**B**	Second Class
00-49	**0.0**	**U**	Re-appear
Absent	**0.0**	**AAA**	ABSENT

Ci= Credits earned for course i in any semester
Gi = Grade Point obtained for course i in any semester
n = refers to the semester in which such course were credited

Grade point average (for a Semester):

Calculation of grade point average semester-wise and part-wise is as follows:

- **GRADE POINT AVERAGE [GPA] = ΣiCiGi / ΣiCi**

Sum of the multiplication of grade points by the credits of the courses offered under each part

GPA = ---

Sum of the credits of the courses under each part in a semester

Calculation of Grade Point Average (CGPA) (for the entire programme):

A candidate who has passed all the examinations prescribed is eligible for the following partwise computed final grades based on the range of CGPA.

CUMULATIVE GRADE POINT AVERAGE [CGPA] = ΣnΣiCniGni / ΣnΣiCni

Sum of the multiplication of grade points by the credits of the entire programme under each part

CGPA = ---

Sum of the credits of the courses of the entire programme under each part

CGPA	GRADE
9.0 and above but below 10.0	O
8.0 and above but below 9.0	D+
7.5 and above but below 8.0	D
6.5 and above but below 7.5	A+
6.0 and above but below 6.5	A
5.0 and above but below 6.0	B

0.0 and above but below 5.0	U

14. Improvement ofMarks in the subjects already passed:

Candidates desirous of improving the marks awarded in a passed subject in their first attempt shall reappear once within a period of subsequent two semesters by paying the fee prescribed from time to time. The improved marks shall be considered for classification but not for ranking. When there is no improvement, there shall not be any change in the original marks already awarded.If candidate improves his marks, then his improved marks will be taken into consideration for the award of Classification only. Such improved marks will not be counted for the award of Prizes / Medals, Rank and Distinction. If the Candidate does not show improvement in the marks, his previous marks will be taken into consideration.

- ❖ No candidate will be allowed to improve marks in the Practicals, Project, Viva-voce and Field work.

15. Classification of Successful candidates:
A candidate who passes all the examinations including practicals securing following CGPA and Grades shall be declared as follows **for Part I or Part II**:

CGPA	GRADE	CLASSIFICATION OF FINAL RESULT
9.0 and above but below 10.0	O	First Class - Outstanding
8.0 and above but below 9.0	D+	First Class with Distinction
7.5 and above but below 8.0	D	
6.5 and above but below 7.5	A+	First Class
6.0 and above but below 6.5	A	
5.0 and above but below 6.0	B	Second Class

a. A candidate who has passed all the examination including practicalsin the first appearance within the prescribed duration of the PG programme and secured a CGPA of 9 to 10 and equivalent grade “O” in Core and Elective subjects shall be placed in the category of “**First Class – Outstanding**”.

b. A candidate who has passed all the examination including practicalsin the first appearance within the prescribed duration of the PG programmes and secured a CGPA of 7.5 to 9 and equivalent grades “D” or “D+” in Core and Elective shall be placed in the category of “**First Class with Distinction**”.

c. A candidate who has passed all the examination including practicalsof the PG programme and secured a CGPA of 6 to 7.5 and equivalent grades “A” or “A+” shall be declared to have passed that parts in “**First Class**”.

d. A candidate who has passed all the examination including practicalsof the PG programmes and secured a CGPA of 5.5 to 6 and equivalent grade “B” shall be declared to have passed those parts in “**Second Class**”.

16. Conferment of the Degree:

No candidate shall be eligible for conferment of the Degree unless the candidate;

i. has undergone the prescribed course of study for a period of not less than four semesters in Thiruvalluvar University or has been exempted from in the manner prescribed and has passed the examinations as have been prescribed therefor.

ii. has completed all the components prescribed under core and elective subjects in the CBCS pattern to earn 94 credits.

17. Ranking

- A candidate who qualifies for the PG degree course passing all the examinations in the first attempt, within the minimum period prescribed for the course of study from the date of admission to the course and secures I or II class shall be eligible for ranking. In the case of candidates who pass all the examinations prescribed for the course with a break in the first appearance due to the reasons as furnished in the Regulations 6(a) (iii) supra are eligible for classification / Distinction.

The marks obtained in improvement examinations shall not be taken into consideration for ranking.

18. Revision of Regulations and Curriculum

The above Regulation and Scheme of Examinations will be in vogue without any change for a minimum period of three years from the date of approval of the Regulations. The University may revise /amend/ change the Regulations and Scheme of Examinations, if found necessary.

ABOUT THE DEPARTMENT

The Department of Physics is proposed for establishment in 2020. The Department will offer M.Sc., M. Phil. and Ph.D., (Full-Time and Part-Time) degree courses with its focus on developing new experimental tools and theoretical approaches to understand the physics and their applications in various fields of science together with the behaviour of matter from atom to celestial level.

OBJECTIVE

The objective of the course is to create awareness in the field of Physics and cultivate scientific approach and research aptitude among the graduate students in various subjects of physics and emerging extensions of research activities. The task includes preparation, enhancement etc. of human resources in strengthening the activities for the development of basic scientific knowledge, skills and application of scientific approach. An independent project is included in the course so that the candidate knows about the flavour of research methodology in science.

Statement of Vision

Physics provides immense scope for study, research and gainful employment in various sectors. The Department of Physics of Thiruvalluvar University is determined to educate and graduate rural students. The department is committed to prepare, compete in and contribute to the needs of modern physical science based industries and academia. To achieve this vision, the department is dedicated to provide a course of study for post-graduate in physics which combines curriculum and research oriented project that are high-quality, innovative and intellectually challenging.

Statement of Mission

The mission of the Department of Physics of Thiruvalluvar University is to advance the physical sciences through the education of post-graduate students in rural society by providing them with quality classroom learning and research opportunities. The department is committed to impart a high standard for excellence in all branches of chemistry by innovative and dedicated teaching at post-graduate level to produce students with good knowledge in chemistry.

THIRUVALLUVAR UNIVERSITY

Department of Physics

M.Sc., Physics (University Department)

UNDER CBCS (With effect from 2020-2021)

The course of study and scheme of examinations

1.TITLE: M.Sc., Physics

2.YEAR OF IMPLIMENTATION: July 2020onwards

3.COURSE DETAILS:

Total No. of Semesters -04 (Two semesters per year)
No. of theory papers per semester -04/03/03/03
Total No. of theory papers -13
No. of practical courses per semester -01
Total No. of Practical - 03(up to III semester)
No of Core Elective papers per Semester -01/01/01/01
No of Open Elective papers per Semester - 00/01/01/00
Total Elective papers - 06
Compulsory MOOC course (Elective) - 01 (in Semester 3)
Compulsory Social paper - 01 (in Semester 2)
Internship - 01 (End of 2nd Semester)
Project -IVsemester

SEMESTER	I	II	III	IV	Total	Credits	Total credit
Core Theory	4	3	3	3	13	4	52
Core Electives	1	1	1	1	4	3	12
Open Elective	0	1	1	0	2	3	6
Core Practical	1	1	1	0	3	4	12
Compulsory Course	0	0	1	0	1	2	2
Value Added course	1	0	0	0	0	2	2
MOOC course	0	0	1	0	1	2	2
Internship	0	1	0	0	1	2	2
Project	0	0	0	1	1	5	5
Credits/Semester	**25**	**23**	**25**	**21**			**94**

Total Marks for M.Sc. Degree

Theory -1300 marks
Practical - 300 marks
Core Electives - 400 marks
Open Electives - 200 marks
Project - 100 marks
Comp. Course - 100 marks
Value Added course - 100 marks
MOOC Courses - 100 marks

Internship	- 100 marks
Total	**-2700 marks**

4.PREAMBLE OF THE SYLLABUS:

Master of Science (M.Sc.) in Physics is a post-graduation course from the academic year 2020-2021of Thiruvalluvar University. The curriculum is prepared by following the prospectus of various national, international universities and research organisations in India. The board of studies framed the syllabus of M.Sc. Physics in 2020 coveringthe broad area of fundamental aspects in Physics and opportunities in research organisations.

The syllabi are all set to meet the standard of CSIR-UGC-NET,GATE and SLET examinations. The credit system to be implemented through this curriculum would allow students to develop a strong footing in the fundamentals and specialize in the disciplines of his/her liking and abilities. The students pursuing this course would have to develop in-depth understanding of various aspects of physics. The conceptual understanding, development of experimental skills, designing and implementation of novel methods, developing the aptitude for academic and professional skills, acquiring basic concepts for optical, nuclear and energy concepts understanding the fundamental and experimental concepts. The internship and project introduced in the curriculum will motivate the students to pursue the research and find a job in reputed research organisations, such as DAE, CSIR, SSPL, IGCAR, ISRO and also in teaching and industries,anywhere.

5. REQUIREMENT TO APPEAR FOR THE EXAMINATION

(i) Minimum 75% attendance required for both theory and practical examinations.
(ii) Attendance of less than 75% but 65% and above has to pay the condonation fee prescribed by the university.
(iii) Attendance less than 65% but 55% and above has to compensate the shortage of attendance in the subsequent semester (in the next year).
(iv) Attendance less that 55% has to rejoin / redo the semester.
(v) In the case of married woman, the minimum attendance should not be less than 55%.

6. PATTERN OF EXAMINATION

Evaluation of Students:

1. All Semester examinations both theory and practical will be of 100 marks Each comprised of both Internal and External assessments.
2. Student has to obtain 50% marks in all the examinations (both theory and practical) secured from both Internal and External assessments.

7.FEE STRUCTURE: As per Thiruvalluvar University norms

8.ELGIBILITY FOR ADMISSION

A candidate who has passed the B.Sc., degree examination with **Physics/Applied Physics as the main subject of study with Chemistry and Mathematics as allied subjects**of this university or an examination of any other university accepted by the syndicate as equivalent thereto shall be eligible for admission to the **M.Sc., degree in Physics** in the university department.

9. MEDIUM OF INSTRUCTION: English.

10.SCHEME OF EXAMINATION

• The semester examination will be conducted at the end of each semester (Both theory & practical examination), for odd semesters in the month of November/December; for even semester in April/May. All theory examination is conducted for 3 hours irrespective of total marks. However, duration of practical examinations is 6 hours.

• **Theory paper** will be of 75 marks each for university examination and 25 marks for internal evaluation.

- **Theory question pattern**

Section-A 10×2	=20 marks	(50 words; no choice)
Section-B 5×5	= 25 marks	(200 words; eitheror type)
Section-C 3×10	= 30 marks	(500 words; 3 out of 5)
Total = 75 marks		

- **Internal Assessment**

Test	: 10 marks (best 2 out of 3)
Assignment	: 10 Marks
Seminar	: 05 Marks
Total	**: 25 marks**

There shall be tutorial / practical / spot test / home assignment / referencing of research papers / seminar / industrial visit / training course as a part of internal assessment in each semester. The students are supposed to attend all the tests. The students should note that re-test will not be given to the student absent for the test/s.

- **Practical examination** will be of 75 marks each for university examination and 25 marks for internal evaluation.

Distribution of marks for practical examinations

University Examination Experiment : 75 Marks

Procedure	: 5 marks
Experiment	: 30 marks
Interpretation	: 10 marks
Result	: 10marks
Practical viva-voce	: 10 marks
Record	: 10 Marks
Total	**: 75 marks**

Practical Internal Assessment

Number of Experiments	: 10 marks
Performance	:10 Marks
Test	: 5 Marks
Total	**: 25 marks**

Passing Minimum in practical examinations

IA	: 12 Marks (50 %)
UE	: 38 Marks (50 %)
Total	**: 50 Marks**

All the practical examinations will be conducted for 6 hours only i.e. 10 AM – 4PM by both the internal examiners.

• For the project report

Report	: 75 marks
Viva-voce	: 25 marks
Total	**: 100 Marks**

Distribution of marks for project report (Total of 100 marks)

Project will be evaluated by the concerned project guide along with a member nominated by the Head of the Department.

Assessment will be done by the departmental committee every month. Evaluation will be on the basis of monthly progress of project work, progress report, referencing, oral, results and documentation.

Project - 75 marks
(Dissertation Format – 10 marks; Scope of the research problem – 20 marks; Methodology – 20 marks; Analysis – 10 marks, Results and findings-15 marks)

Viva-Voce examination – 25 marks
(Presentation – 10 marks; subject knowledge – 10 marks; Interaction – 5 marks)

11. Question papers will be set in the view of the entire syllabus and preferably covering each unit of the syllabus.

12.STANDARD OF PASSING
A candidate should get not less than 50% in the university examination, compulsorily, in all papers, including practical. Also, the candidate who secures not less than 50% marks in the UE and IA examinations put together in any theory paper/practical shall be declared to have successfully passed the examination.

- Internal marks will not change. Student cannot repeat internal assessment. If student misses internal assessment examination, s/he will have to score passing minimum in the external examinations only.

<u>Illustration:</u> Theory – Internal Assessment -12 marks and University Examination-38 marks

OR

Internal Assessment-0 marks and University Examinaiton-50 marks.

- There shall be revaluation of answer script of end semester examination, but not of internal assessment papers.
- Internal assessment answer scripts may be shown to the concerned student but not end semester answer script.

❖ A candidateshall be declared to have passed the whole examination if the candidate passes in all theory and practical by earning 90 credits in core and elective subject.

13. TRANSITORY PROVISION

This curriculum is valid for three years only (2019-20 to 2021-22), as per UGC norms. Hence, candidates who have undergone M.Sc., Physics course in the University department will be permitted to re-appear for next two consecutive years only. After that, he/she has to re-appear for the examinations under new curriculum, regulations, which are in force at that time.

Board of Studies for University Department

Board of Studies in Physics

S.No	Name and Address	Designation
1.	Dr. K. Sivaji, Professor and Head, Department of Nuclear Physics, University of Madras,Guindy, Chennai – 600025. 044-22202805, 9840233770 sivaji@unom.ac.in, k_sivaji@yahoo.com	**Chairman**
2.	Prof. T. Rajesekaran, Professor and Head, Department of Physics,Department of Energy Sciences,ManonmaniamSundaranar University, Abhisekapatti, Tirunelveli – 627012. 9442327921. trrajasekaran@gmail.com	Member
3.	Prof. K. Murali, Professor,Department of Physics, Anna University,Guindy, Chennai – 600 025. 044-22358691, 09677291394.kmurali@annauniv.edu	Member
4.	Prof. S. Rajasekar, Professor and Chair, Department of Physics,Bharathidhasan University, Tiruchirappalli – 620024.0431 – 2407057, 09442539305 srj.bdu@gmail.com, rajasekar@cnld.bdu.ac.in	Member
5.	Dr.MajariBagchi, Reader, Theoretical Physics, Institute ofMathematical Sciences (IMSc), CIT Campus, Taramani, Chennai – 600013. 04422543205, 09677146926, manjari@imsc.res.in	Member
6.	Dr. S. Sivaprakasam, Associate Professor, Department of Physics, Pondicherry University, Puducherry – 605 014.09442288762, prakasam.phy@pondiuni.edu.in,siva@iitk.ac.in	Member
7.	Dr.Hariharan, Scientific Officer, Comic Ray Laboratory Raj Bhavan, TIFR, Ooty – 643 001.(A division of National Centre for radioAstrophysics)09865356720, hariharan@crl.tifr.res.in	Member
8.	Prof. G. Ambika, Professor, Indian Institute of Science Education and Research,C/o	Member

	Sree Rama Engineering College (TransitCampus), Rami Reddy Nagar,Karakambadi Road,Mangalam (post), Tirupati – 517507. AP 918772500230, g.ambika@iisertirupathi.ac.in	
9.	Dr. F. Liakath Ali Khan, Associate Professor,Department of Physics, Islamiah College,Vaniyambadi – 635 752. 9445913721, shamisardar@yahoo.com	Member
10.	Dr. C. Muthumariappan, Associate Professor of Astrophysics, Indian Institute of Astrophysics, Bangalore. Kavalur Observatory In-charge,Kavalur, Alangayam – 635701.Vellore Dt. TN. 9047497972. muthu@iiap.res.in	Member

THIRUVALLUVAR UNIVERSITY
(With effect from 2020 – 2021)

DEPARTMENT OF PHYSICS
MASTER OF SCIENCE DEGREE COURSE
M.Sc. PHYSICS
CBCS PATTERN

With effect from 2020-2021

The course of study and the scheme of Examination

	Study Components		*ins. hrs / week*	*Credit*	*Title of the Paper*	*Maximum Marks*		
	Course Title					*CIA*	*Uni. Exam*	*Total*
SEMESTER I								
	CORE-1	Paper-1	4	4	MATHEMATICAL PHYSICS – I	25	75	100
	CORE-2	Paper-2	4	4	CLASSICAL MECHANICS	25	75	100
	CORE-3	Paper-3	4	4	ELECTRONICS AND INSTRUMENTATION	25	75	100
	CORE-4	Paper-4	4	4	OPTOELECTRONICS	25	75	100
	CORE-5	Practical Paper-1	8	4	GENERAL PRACTICAL – I	25	75	100
	Value Added Course		3	2	Digital Photography	25	75	100
Internal Elective for same major students (Choose any one)								
	Core Elective	Paper-1	3	3	A. ELECTRONIC COMMUNICATIONS B. LASER AND FIBER OPTICS A. PHYSICS OF MATERIALS	25	75	100
			30	25				
SEMESTER II						*CIA*	*Uni. Exam*	*Total*
	CORE-6	Paper-5	5	4	MATHEMATICAL PHYSICS – II	25	75	100
	CORE-7	Paper-6	4	4	ELECTROMAGNETIC THEORY	25	75	100
	CORE-8	Paper-7	4	4	QUANTUM MECHANICS – I	25	75	100
	CORE-9	Practical Paper-2	10	4	ADVANCED PRACTICAL	25	75	100
Internal Elective for same major students (Choose any one)								
	Core Elective	Paper-2	3	3	A. ASTROPHYSICS B. SEMICONDUCTOR PHYSICS C. COMPUTATIONAL PHYSICS	25	75	100
External Elective for other major students (Inter/multi-disciplinary papers) (Choose any one)								
	Open Elective	Paper-1	2	2	A.Materials CharacterizationB.Disaster Management **C.**Clean Energy Science	25	75	100
	Compulsory Paper		2	2	Human Rights	25	75	100
			30	**23**				

	Study Components		ins. hrs / week	Credit	Title of the Paper	Maximum Marks		
	Course Title					CIA	Uni. Exam	Total
SEMESTER III								
	CORE-10	Paper-8	5	4	QUANTUM MECHANICS – II	25	75	100
	CORE-11	Paper-9	4	4	SOLID STATE PHYSICS – I	25	75	100
	CORE-12	Paper-10	4	4	THERMODYNAMICS STATISTICAL MECHANICS	25	75	100
	CORE-13	Practical Paper-3	12	4	PRACTICAL III – NUMERICAL METHODS USING PYTHON	25	75	100
Internal Elective for same major students (Choose any one)								
	Core Elective	Paper-3	3	3	A. PYTHON PROGRAMMING B. NONLINEAR SCIENCE **C.** FIBER OPTIC COMMUNICATION	25	75	100
External Elective for other major students (Inter/multi-disciplinary papers) (Choose any one)								
	Open Elective	Paper-2	2	2	A. Basis Of Renewable Energy Sources B.Intellectual Property And Patenting C.Nanomaterials and its Applications	25	75	100
	MOOC Courses		-	2	MOOCS COURSES	25	75	100
	USRR		-	2	UNIVERSITY SOCIAL RESPONSIBILITY REPORT (INTERNSHIP)	25	75	100
			30	**25**				
SEMESTER IV						***CIA***	***Uni. Exam***	***Total***
	CORE-14	Paper-11	4	4	SPECTROSCOPY	25	75	100
	CORE-15	Paper-12	5	5	NUCLEAR AND PARTICLE PHYSICS	25	75	100
	CORE-16	Paper-13	4	4	SOLID STATE PHYSICS – I I	25	75	100
	Core-17	Project Compulsory	14	5	Project with *viva voce*	100 (75 Project +25 viva)		100
Internal Elective for same major students (Choose any one)								
	Core Elective	Paper-4	3	3	A. NANOSCIENCE B. RADIATION AND DETECTORS C. ENERGY AND STORAGE DEVICES	25	75	100
			30	**21**				
			120	**94**				

SEMESTER-I: CORE-1

MATHEMATICAL PHYSICS- I **L T P C**

3 1 0 4

Pre-Requisite: Students should have the preliminary knowledge of basic mathematical physics learned in undergraduate level

OBJECTIVE

- To introduce the students the concept of differential equations.
- To make the students to understand special functions and its uses.
- To make the student to study the aspect of probability.
- To involve the student to learn vector calculus.
- To educate the students in understanding linear vector spaces and matrices.

UNIT I DIFFERENTIAL EQUATIONS

First and second order ordinary differential equations with constant coefficients–Initial value problem – Method of finding solutions – Superposition principle – Wronskian - Second order differential equations with variable coefficients – Definition of ordinary and singular points–Power Series Solution – Examples – Solutions about ordinary point and singular point – Taylor series method and Frobenius Method.

UNIT II SPECIAL FUNCTIONS

Strum-Liouville problem - Basic properties – Need for studying Sturm-Liouville problems in physics – Specific examples - Legendre, Bessel, Hermite and Laguerre differential equations – Power series solutions – Polynomials – Generating functions – Rodrigue's formula - Recursion relations – Orthogonality relations.

UNIT III PROBABILITY

Probability - Addition rule of Probability - Multiplication Law of Probability - Probability distribution - Binomial distribution – The first four moments of Binomial distribution - Poisson distribution - Normal distribution – The first four moments of Poisson and Normal distribution - Applications of Binomial, Poisson and Normal distributions – Central limit theorem.

UNIT IV VECTOR CALCULUS

Vector integration – Line integral – Path independence – Exact differential – Surface integral – Flux – Volume integral – Green's theorem – Stokes' theorem – Divergence theorem – Orthogonal curvilinear coordinates – Unit vectors in curvilinear coordinate system – Arc length and volume element – The gradient, divergence, curl and Laplacian in cylindrical and spherical polar coordinates.

UNIT V LINEAR VECTOR SPACES AND MATRICES

Definition of linear vector space – Examples – Linear independence – Basis and dimensions of a vector space – Scalar product – Orthogonality of vectors – Linear transformation – Linear operator – Matrix representation of a linear operator – Matrix algebra – System of linear equations – Symmetric, anti-symmetric and orthogonal matrix– Hermitian, skew- Hermitian and Unitary matrix – The Inverse of a matrix – Eigenvalues and eigenvectors of a square matrix – Cayley–Hamilton theorem – Diagonalisation.

REFERENCES

1. L.A.Pipes and L.R.Harvill. Applied Mathematics for Engineers and Physicists. Dover Publications Inc., 2014.
2. H.J.Weber and G.B.Arfken, Essential Mathematical Methods for Physicists, Academic Press, 2003.
3. E.Kreyszig. Advanced Engineering Mathematics. Wiley, 2015.
4. E. Butkov. Mathematical Physics. Addison Wesley, New York, 1973.
5. K.F.Riley, M.P.Hobson and S.J.Bence, Mathematical Methods for Physics and Engineering, Cambridge University Press, 1998.

SEMESTER-I: CORE 2

CLASSICAL MECHANICS **L T P C**
3 1 0 4

Pre-Requisite: Students must have learnt Newtonian Mechanics at UG level

OBJECTIVE

- To develop familiarity with mechanical aspects of systems and mathematical methods of Classical Mechanics.
- To make the students understand the concepts laws of central force motion and rigid body dynamics
- To make the students understand Hamilton's formulation
- To enable the students to understand the concept of chaotic dynamics
- To make the students understand the basic concepts of relativistic mechanics.

UNIT I DYNAMICAL SYSTEMS AND LAGRANGE'S FORMULATION

Dynamical systems, phase-space dynamics and stability analysis - Mechanics of a system of particles - Constraints - Generalized coordinates - D'Alembert's principle and Lagrange's equations - Velocity dependent potentials and dissipation function - Simple application of the Lagrangian formulation - Hamilton's (variational) principle and derivation of Lagrange's equations - shortest distance problem, brachistrochrone - Generalized momenta and energy, and cyclic coordinates - Conservation laws - problems.

UNIT II CENTRAL FORCE MOTION AND RIGID BODY DYNAMICS

Central Force Motion: General features - The Virial theorem - differential equation for the orbit, and integrable power-law potentials - Bertrand's theorem. The Kepler problem: inverse square law force - Scattering in a central force field - three body problem. Rigid Body Dynamics: Moment of inertia tensor - Euler angles - Euler's equations of motion - Torque-free motion of a rigid body - Heavy symmetrical top - problems.

UNIT III HAMILTON'S FORMULATION

Legendre transformation - Hamiltonian and Hamiltons equation of motion - Properties - Derivation of Hamiltons equations from variational principle - Canonical transformation - Applications - Poisson brackets - Hamilton-Jacobi equation for Hamilton's principle function - Hamilton's characteristic function - Application (Harmonic oscillator) - Separation of variables - Action angle variables - problems.

UNIT IV OSCILLATIONS AND CLASSICAL CHAOS

Small Oscillations: Theory of small oscillations - Eigenvalue problem - Frequencies of free vibrations - Normal coordinates - coupled pendulums- Linear triatomic molecule – forced vibrations – dissipation - Classical Field Theory: Lagrangian and Hamiltonian formulation of continuous system - problems. Chaos: Periodic motion - perturbations and the KAM theorem - attractors - chaotic trajectories - Poincare maps - Henon-Heiles Hamiltonian - bifurcations - logistic equation.

UNIT V RELATIVISTIC MECHANICS

Inertial and non-inertial reference frames - Addition of velocities, mass, energy - Mass- Energy equivalence - Pseudo forces - Galilean & Lorentz transformations - Invariance of Maxwell's equations under Lorentz transformation - Lagrangian and Hamiltonian of relativistic particles - problems.

REFERENCES

1. H.Goldstein, C.P.Poole and J.Safko. Classical Mechanics. Pearson Education, Inc. 2017.
2. N.C.Rana and P.S.Joag. Classical Mechanics.McGraw Hill Education, 2017.
3. A.L. Fetter and J.D. Walecka, Theoretical Mechanics of Particles and Continua, Dover Publications, Inc., (2003)

4. R.Douglas Gregory, Classical Mechanics, Cambridge University Press, 2006
5. S.T.Thornton and J.B. Marion, Classical Dynamics of Particles and Systems, Brooks/Cole, 2007

SEMESTER-I: CORE 3

ELECTRONICS AND INSTRUMENTATION **L T P C**
3 1 0 4

Pre-Requisite: To introduce the concepts of nanoelectronics and physics aspects to the students.

OBJECTIVE

- To make the students to understand the concept of analog electronics.
- To introduce the advanced concepts of digital electronics.
- To educate the students on the concepts of optoelectronics.
- To equip the students for designing electronic instruments.

UNIT I ANALOG ELECTRONICS

Semiconductor devices: Metal - semiconductor contacts - Schottky barrier diode - Zener diode-varactor diode - tunnel diode - Characteristics of FET and MOSFET. Operational amplifiers: Introduction – differential amplifier – op-amp parameters – feedback-comparators – mathematical operations – analog simulation circuits - oscillators – active filters – active diode circuits – OTAs. Voltage regulators: Principles and operations – Nonlinear electronics: Ideas, implications and applications - forced LCR circuit, MLC circuit and memristor oscillators.

UNIT II DIGITAL ELECTRONICS

Overview of logic functions and logic gates – combinational logic: Implementation of combinational logic - binary adders - comparators - decoders, encoders, Conde converters, multiplexers, demultiplexers. Sequential logic: Flip-flops and related circuits – astablemultivibrator - registers, counters, shift-registers and memory – programmable logic devices - macrocell models - FPGAs - microprocessor architecture – A/D a DSP fundamentals.

UNIT III OPTOELECTRONICS

LEDs – semiconductor lasers – photodiodes – solar cells – photodetectors – optical fibers – communication – optoelectronic modulation and switching devices – optocoupler – optical data storage devices – display devices.

UNIT IV ELECTRONIC INSTRUMENTATION

Basics of instrumentation system – transducers – types of transducers – strain gauges – RTDs – LVDT – piezoelectric transducers – load cell – flow meters – signal conditioning. Data conversion: Analog switches - sample-and-hold amplifiers - isolations amplifiers - instrumentation amplifier - D/A conversation - A/D conversation - voltage-to-frequency and frequency-to-voltage converters. Measurement and control: RMS-to-DC converters - angle measurement - motion measurement and power control.

UNIT V NANOELECTRONICS

MOSFETs - `electron transport in nanostructures - resonant tunneling diodes – single electron transfer devices – molecular switches and memory storage – nano-electromechanical systems -quantum dot cellular automata.

REFERENCES

1. A.P.Malvino. Electronic principles. Tata McGraw-Hill, 2011.
2. T.L.Floyd and D.M.Buchla, Analog fundamentals: A systems approach, Pearson, 2013.
3. P.Horowitz and W.Hill. Art of electronics. Cambridge Univ.Press, 2006.
4. L.O.Chua, C.A.Desoer and E.S.Kuh. Linear and Nonlinear Circuits. McGraw-Hill, 1997.
5. M.Lakshmanan and K.Murali. Chaos in Nonlinear Oscillators. World Scientific, 1996.
6. P.Bhattacharya. Semiconductor Optoelectronic Devices. Pearson Education, 2017.
7. H.S.Kalsi. Electronic Instrumentation. McGraw Hill Education, 2017.
8. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education Inc., 2009.

SEMESTER-I: CORE 4

OPTOELECTRONICS **L T P C**
3 1 0 4

Pre-Requisite: Basic Solid State Physics

OBJECTIVES

- To make the students in gaining knowledge on physics theory of semiconductor devices.
- To make the students to understand the working of semiconductor photon sources.
- To educate the students on the aspects of semiconductor photodetectors.
- To impart knowledge on the methods of optoelectronic modulations and switches.
- To introduce the working principles of optoelectronic integrated circuits.

UNIT I PHYSICS OF SEMICONDUCTOR DEVICES

Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells.

UNIT II SEMICONDUCTOR PHOTON SOURCES

Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier. Electroluminescence. The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation. Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL); Laser diode arrays. Semiconductor optical amplifiers (SOA), SOA characteristics and their applications.

UNIT III SEMICONDUCTOR PHOTODETECTORS AND SOLAR CELLS

Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection; Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance. Photo-transistors and CCDs – Noise in photodetectors – photovoltaic device principles – PN junction photovoltaic characteristics – temperature effects – solar cells materials, devices and efficiencies.

UNIT IV OPTOELECTRONIC MODULATION AND SWITCHING DEVICES

Analog and digital modulation – Franz-Keldysh and Stark effect modulators – quantum well electo-absorption modulators. Optical switching and logic devices: self-electro-optic device – bipolar controller-modualtor – switching speed and energy.

UNIT V OPTOELECTRONIC INTEGRATED CIRCUITS

Hybrid and monolithic integration – applications of Optoelectronic Integrated Circuits (OEICs) – materials and processing for OEICs – integrated transmitters and receivers – guided wave devices – optical interconnects.

REFERENCES:

1.Pallab Bhattacharya, "Semiconductor optoelectronic devices", PHI Pvt. Ltd., New Delhi (2009).
2. S.O. Kasap, "Optoelectronics and photonics", Pearson, New Delhi (2013).
3. C.R. Pollock, "Fundamentals of optoelectronics", Irwin, Chicago (1995).
4. J. Wilson, "Optoelectronics: An Introduction", Prentice-Hall (1997).
4. Ammon Yariv, Quantum Electronics, (3rd Edition), Wiley India Pvt. Ltd., New Delhi (2012).
5. A. Ghatak and K. Thiagarajan, "Optical electronics", Cambridge University Press, (2013).

SEMESTER -I: CORE 5

GENERAL PRACTICAL - I **L T P C**
0 0 6 4

Pre-Requisite: None

OBJECTIVES

1. To make the students to understand experimental physics
2.To apply the theoretical knowledge for developing new devices

(Any 15 out of the given 25)

1. Cornu's method - Young's modulus by elliptical fringes.
2. Cornu's method - Young's modulus by hyperbolic fringes.
3. Determination of Stefan's constant.
4. Band gap energy - Thermistor.
5. Hydrogen spectrum - Rydberg's constant.
6. Co-efficient of linear expansion - Air wedge method.
7. Permittivity of a liquid using RFO.
8. Viscosity of liquid - Meyer's disc.
9. Solar spectrum - Hartmann's Interpolation formula
10. F.P. Etalon – spectrometer – determination of spacing between two plates
11. Iron / Copper arc spectrum.
12. Brass / Alloy arc spectrum.
13. B-H loop using Anchor ring.
14. Specific charge of an electron -Thomson's method / Magnetron method.
15. Electrical resistance of a metal / alloy as a function of temperature by four probe method
16. Edser and Butler fringes - Thickness of air film.
17. Spectrometer - Polarisability of liquids.
18. Spectrometer - Charge of an electron.
19. Determination of strain hardening co-efficient.
20. Thickness of the enamel coating on a wire - by diffraction.
21. Lasers: Study of laser beam parameters.
22. Measurement of Numerical aperture (NA) of a telecommunication graded index optic fiber.
23. Fiber attenuation of a given optical fiber.
24. Determination of solar constant.
25. Biprism - Wavelength of monochromatic source - Refractive Index of a liquid.

SEMESTER-I: COREELECTIVE PAPER

ELECTRONIC COMMUNICATIONS **L T P C**
2 1 0 3

Pre-Requisite: Basic Electronics

OBJECTIVES

- To introduce the design aspects of oscillator circuits.
- To make the students to understand the concept of amplitude modulation and techniques.
- To elucidate the aspects of frequency modulation.
- To introduce the concepts of transmission lines and their applications.
- To make the students to apply the knowledge of antenna theory.

UNIT I OSCILLATOR CIRCUITS

Series resonant LC circuit - determination of current, voltage, phase and frequency in series RLC circuit - parallel resonant LC circuit, determination of current, voltage, phase and frequency in parallel RLC circuit - resonant series-parallel circuits - bandwidth of resonant circuits - transformer coupling - tuned amplifiers - RF oscillator circuits - phase-locked loops - frequency synthesisers.

UNIT II AMPLITUDE MODULATION

Mathematical description - power content - determination of percent modulation - frequency spectrum of the AM wave - AM transmitter design - modulated transistor amplifiers - SS, DS and PC transmission - balanced modulator - AM receivers.

UNIT III FREQUENCY MODULATION

Mathematical representation of FM - frequency spectrum of FM - phase modulation - Percent modulation - sidebands - center frequency and bandwidth allocations - deviation ratio - effects of noise on carrier - narrowband FM versus sideband FM - FM receivers and transmitters - stabilised reactance modulator.

UNIT IV TRANSMISSION LINES

Basics - pulse on a transmission line - a sine wave on a transmission line - characteristic impedance - losses in transmission lines - reflected waves and standing-wave ratio - standing waves reflected power - velocity power— quarter and half-wavelength lines - reactance properties of transmission lines - Smith chart and its applications - transmission line components.

UNIT V ANTENNAS

Radiation pattern - elementary doublet - beam width - antenna resistance - antenna as a resonant circuit - velocity factor - antenna types - antenna gain - front-to-back ratio - reflectors and directors - antenna traps - wave propagation - waveguides.

REFERENCES

1. Lloyd Temes and M.E. Schultz, Schaum’s Outline of Theory and Problems of Electronic Communication, McGraw-Hill, 1998.
2. G. Kennedy and B. Davis, Electronic Communication Systems, Tata-McGraw Hill, 2009.
3. T.L.Floyd, Principles of Electric Circuits, Pearson, 2014.
4. P.Horowitz and W.Hill. Art of electronics. Cambridge Univ.Press, 2006.
5. A.P.Malvino. Electronic principles. Tata McGraw-Hill, 2011.

SEMESTER-I: CORE ELECTIVE PAPER

A. LASER AND OPTICS

L T P C
2 1 0 3

Pre-Requisite: The basic knowledge on Applied Physics and its application

OBJECTIVE

To introduce knowledge on basics of lasers and its application
To make the students understand about theoretical studies on laser systems.
To impact the basic knowledge on laser system compound.
To introduce the knowledge about various laser systems.
The students will be able to know about laser system used for materials processing.
To impact knowledge on the laser applications.

Unit – I Geometrical Optics

Fermat's principle: Principle of extreme path, General theory of image formation, Interference of light: The principle of superposition; two-slit interference, Fabry-Perot interferometer and etalon, Michelson interferometer, Fraunhofer diffraction - Diffraction at a circular aperture, Resolution of images; Rayleigh criterion, Diffraction at N parallel slits; Resolving power of gratings and prisms.

Unit – II . Optics of Dielectric Media

Maxwell's equations; Wave equations - free space and Dielectic media - Origin of complex refractive index; Absorption and dispersion, Coherence; Quantum theory of Atomic energy levels & selection rules for single electro & multi-electron atoms.

Unit – III. Lasing Conditions

Laser as Coherent Source of light: Purity of a spectral line; coherence length and coherence time, spatial coherence and directionality – Lasing requirements: Decay of excited states, Emission broadening & line width due to radiative decay, absorption and stimulated emission- Einstein's A & B Coefficient. Condition for producing a laser – population inversion, gain & gain saturation; Saturation intensity.

Unit – IV

Laser Engineering: Stable laser resonators & propagation of Gaussian beams using ABCD matrices, Properties of laser modes –Mode characteristics & effect of modes in gain profile,. Threshold requirement for a laser, laser oscillation above threshold. Requirements for obtaining population inversion- 2, 3 and 4 level systems; Steady state and transient population process that destroy population Inversion.

Unit- V : Types of Lasers:

Classification of lasers based on its output power, Classification of laser based of populations and phase relaxation times – Class A, B and C lasers. Solid state laser :Nd:YAG , Ti-Sapphire lasers, Liquid lasers : Dye Laser, Gas lasers : He-Ne and Carbon – di – oxide lasers.

Text Books:

1. A. K. Ghatak, Optics, Tata McGraw Hill, 3rd Edition.
2. Eugene Hecht, Optics, Addison Wesley, (2001), 4th Edition.
3. F. L. Pedrotti and L. S. Pedrotti, Introduction to Optics, Prentice Hall International, 2nd Edition.
4. B. B. Laud, Lasers and Non-linear Optics, Wiley Eastern, (1985).
5. William T .Silfvast, Laser Fundamentals.

Books for Additional Reading

1. AmnonYariv, Quantum Electronics.
2. K. K. Sharma, Optics, Elsevier.
3. Peter W MIlonni& Joseph H .Eberly, Lasers.

SEMESTER-I:CORE ELECTIVE PAPER

B. PHYSICS OF MATERIALS **L T P C**

2 1 0 3

Pre-Requisite:

To impart knowledge on various properties of materials with examples

OBJECTIVE

- To introduce the concepts of various mechanical test and plastic deformation the students. To introduce the students about various dielectric materials and their application.
- To expose the students to different types of magnetic materials and their properties.
- The various applications used in magnetic materials.
- To study the properties of various optical materials, LED and LCD and their applications.
- To make the students understand about various properties of smart materials, shape memory alloys CCD and nanomaterials and their applications.

UNIT I MECHANICAL PROPERTIES

Plastic deformation by slip – the shear strength of perfect and real crystals -dislocation movement – methods of strengthening against plastic yield – Creep – mechanisms – fracture – ductile fracture – brittle fracture – Griffith criterion – fracture toughness – fatigue fracture - mechanical tests - tensile, hardness and creep tests.

UNIT II DIELECTRIC PROPERTIES

Dielectric constant and polarizability - different kinds of polarization - Internal electric field in a dielectric -Clausius- Mossotti equation - dielectric in a ac field - dielectric loss - ferroelectric - types and models of ferro electric transition - electrets and their applications – piezoelectric and pyroelectric materials.

UNIT III MAGNETIC PROPERTIES

Classification of magnetic materials- origin of magnetism – Langevin and Weiss theories - exchange interaction - magnetic anisotropy - magnetic domains - molecular theory – hysterisis - hard and soft magnetic materials - ferrite structure and uses - magnetic bubbles - magnetoresistance - GMR materials - dilute magnetic semiconductor (DMS) materials.

UNIT IV OPTICAL PROPERTIES

Optical absorption in insulators, semiconductors and metals – band to band absorption – luminescence - photoconductivity. Injection luminescence and LEDs - LED materials - superluminescent LED materials - liquid crystals - properties and structure - liquid crystal displays- comparison between LED and LC displays.

UNIT V ADVANCED MATERIALS

Metallic glasses - preparation, properties and applications - SMART materials - piezoelectric, magnetostrictive, electrostrictive materials - shape memory alloys - rheological fluids - CCD device materials and applications - solar cell materials (single crystalline, amorphous and thin films) - surface acoustic wave and sonar transducer materials and applications - introduction to nanoscale materials and their properties.

REFERENCES

1. V.Raghavan, Materials Science and Engineering: A First Course. PHI Learning, 2015.
2. S.O.Kasap. Principles of Electronic Materials and Devices. McGraw-Hill Education, 2017.
3. C.Suryanarayana and A.Inoue. Bulk Metallic Glasses, CRC Press, 2017.
4. K.Otsuka and C.M.Wayman. Shape Memory Materials, Cambridge University Press, 1998.

SEMESTER-I:VALE ADDED COURSE

DIGITAL PHOTOGRAPHY

L T P C
21 0 2

Pre-Requisite: Basic of Photography

OBJECTIVES

- To create opportunities for professional and creative expression through the practice and art of photography.
- To inculcate aesthetic sense involved in creativity.
- To get to know the genres of photography

UNIT I Camera
Different camera formats, working of an SLR, DSLR and Mirrorless Cameras. Features and functions of SLR and DSLR Cameras. Various camera controls. Anseladams Zone system. Exposure. Image sensors. Different storage formats.

UNIT II Lens and Elements of Photography
Different type of Lenses - Basic Shots and Camera Angles, Photographic Composition -View pointand Camera angle-Eye Level, Low and High, Balance- Aspects of Balancing, Shapes and Lines,Pattern, Volume, Lighting, Texture, Tone, Contrast- and Colour, Framing, various Perspectives.

UNIT III Colourand Lighting
Colour Theory, Colour Temperature, Electromagnetic spectrum, Lighting Philosophies – Basicstyles of Lighting – Properties of Light – Additive and Subtractive Light – Contrast and LightingRatios – Direct and Indirect Light – Three point and Five Point Lighting – Light Sources. Light meters and filters

UNIT IV People and Portrait Photography
Indoor and outdoor lighting techniques for portraits, the Casual Portrait, Environmental Portraits, Group Portraits, Familiar Subjects, Hands and Other Details.

UNIT V Genres of Photography
Basic shooting and Lighting Techniques and Equipments required for different genres of Photography like Black and White, Landscape, Cityscape, Architecture, Advertising, Table top photography Fashion, Food, Automobile, Sports, Travel, Children, Portrait, wild life, Still Life, Event, Silhouette, Festival and Themes.

REFERENCES

1. Ansel Adams, The Negative, Bulfinch press, Fourteenth Edition, 2008.
2. BalakrishnaAiyer, Digital Photojournalism, Authors press, 2005
3. Ben long, Complete Digital Photography, Charles River Media, Third Edition, 2005
58
4. Fil Hunter, Steven Biver, Paul Fuqua, Light - Science & Magic: an Introduction to Photographic Lighting, Focal Press,2007
5. Langford Bilissi,Langford's Advanced Photography, focal press, Seventh Edition, 2008.
6. Scott Kelby, The Digital Photography Book, Peachpit Press, 2009

SEMESTER-II:CORE 6

MATHEMATICAL PHYSICS - II **L T P C**
3 1 0 4

Pre-Requisite: Mathematical physics and itsapplications.

OBJECTIVE

- To introduce the students to understand the concept of Green's functions.
- To make the students to understand the concept of complex analysis.
- To make the student in gaining knowledge on Fourier transforms.
- To involve the student to learn the Laplace transforms.
- To educate the students to develop the understanding of tensor analysis.

UNIT I GREEN'S FUNCTIONS AND INTEGRAL EQUATIONS

Green's Functions – Properties – Methods of solutions in one, two and three dimensions Applications – Linear integral equations - Hilbert-Schmidt kernels – Fredholm alternative – Neumann series – Applications.

UNIT II COMPLEX ANALYSIS

Complex functions and variables – Condition for a function to be analytic– Complex integration – Cauchy's theorem – Cauchy's integral formula – Taylor expansion – Laurent series – Cauchy's residue theorem – Computations of residue – Evaluation of integrals using residues.

UNIT III FOURIER SERIES AND TRANSFORMS

Fourier Series: Determination of Fourier coefficients – Fourier series for periodic functions – Half-range series – Fourier Integral Theorem – Fourier transforms – Fourier cosine and sine Transforms – Heat equation (one dimension).

UNIT IV LAPLACE TRANSFORMS

Properties of Laplace transform – Inverse Laplace transform – Laplace transform of derivatives – multiplication and division – solution of second-order linear ordinary differential equations by Laplace transform – Applications.

UNIT V TENSOR ANALYSIS

Transformation of coordinates – summation convention – Kronecker delta - Contravariant, Covariant and mixed tensors – Rank of a tensor –Symmetric and anti-symmetric tensors – Inner and outer product - Contraction of a tensor – Quotient Law - Raising and lowering of suffixes – Metric tensor – Conjugate tensors – Christoffel symbols of first and second kind – Covariant derivatives.

REFERENCES

1. L.A.Pipes and L.R.Harvill. Applied Mathematics for Engineers and Physicists. Dover Publications Inc., 2014.
2. E.Kreyszig. Advanced Engineering Mathematics. Wiley, 2015.
3. B.R.Kusse and E.A. Westwig, Mathematical Physics: Applied Mathematics for Scientists and Engineers, Wiley-VCH, 2006.
4. B.S.Grewal. Higher Engineering Mathematics, Khanna Publishers, 2015.
5. Sathya Prakash. Mathematical Physics. Sultan Chand & Sons, 2014.
6. B.D.Gupta. Mathematical Physics. Vikas Publishing House Pvt. Ltd., 2009
7. V. Balakrishnan, Mathematical Physics with applications, problems and solutions, Ane Books, 2017.

SEMESTER-II: CORE 7

ELECTROMAGNETIC THEORY **L T P C**

3 1 0 4

Pre-Requisite: Insight on fundamental laws of optics

OBJECTIVE

(i) To understand the fundamental theories that explain electrostatics and magnetostatics,

(ii) To illustrate the application of electrostatics in macroscopic media,

(iii) To couple the electrostatics and magnetostatics phenomena and explain the elementary ideas of electromagnetic theory

(iv) (iv) To extend the electrodynamics principle for explaining the electromagnetic optical wave propagation

UNIT I ELECTROSTATICS

Coulomb's law – Gauss' law – Divergence and curl of electrostatic field – Electric field and potential due to an electric dipole – Poisson and Laplace Equations – Boundary conditions and uniqueness theorem – Green's theorem – Method of Images – Illustrations: Point charge in the presence of (i) a grounded conducting sphere (ii) an insulated conducting sphere (iii) a charged and insulated sphere – Conducting sphere in an uniform electric field.

UNIT II MACROSCOPIC MEDIA

Electric qudrapole and multipole - Multipole expansion of electric field – Dielectric polarization – External field of a dielectric medium – Electric field in a material medium – Field due to a polarized sphere – Dielectric sphere in a uniform field Molecular field in dielectric: The ClausiusMossotti relation – Electrostatic energy in dielectric media.

UNIT III MAGNETOSTATICS

Biot and Savart law – Force between current carrying conductors – Lorentz force Ampere's law – Divergence and curl of magnetic induction – Comparison of electrostatics and magnetostatics – Magnetic vector potential – Magnetic field of a distant current loop – Magnetic field due to an infinite current carrying wire – Faraday's law of induction – Self and Mutual Inductance.

UNIT IV ELECTROMAGNETICS

Maxwell's displacement current – Maxwell equations and its derivation – Maxwell equations in free space, linear isotropic medium and harmonically varying fields – Conservation of energy (Poynting's theorem) – Conservation of momentum for electromagnetic fields – Plane electromagnetic waves in (i) free space, (ii) nonconducting medium and (iii) conducting medium (isotropic and anisotropic).

UNIT V WAVE PROPAGATION

Polarization of electromagnetic waves (Linear, circular and elliptical polarization) – Reflection and refraction of electromagnetic waves at a plane interface between dielectrics – Fresnel's equation – Total internal reflection – Propagation of electromagnetic waves between parallel conducting medium – Waveguides (i) circular (ii) cylindrical and (iii) rectangular.

REFERENCES

1. 1. J. D. Jackson, Classical Electrodynamics (Wiley Eastern Ltd., New Delhi, 1999)
2. 2. D. Griffiths, Introduction to Electrodynamics (Prentice-Hall of India, New Delhi, 1999)
3. 3. R. P. Feynman, R. B. Leighton and M. Sands, The Feynman Lectures on Physics: Vol. II
4. (Narosa Book Distributors, New Delhi, 1989)
5. 4. Satya Prakash, Electromagnetic Theory and Electrodynamics (KedarNath Ram Nath,Meerut, 2015)

SEMESTER-II:CORE 8

QUANTUM MECHANICS - I　　　　L T P C

3 1 0 4

Pre-Requisite: The course is on the fundamental topics of quantum mechanics

OBJECTIVES

- To introduce the basic postulates of quantum mechanics.
- To make the students to understand different types of operators and exactly solvable systems.
- To elucidate the aspects of time-independent and time-dependent perturbation theories.
- To introduce the concepts of orbital and spin angular momenta.
- To make the students to understand relativistic quantum mechanics.

UNIT I　　THE SCHRODINGER EQUATION AND OPERATORS

Electrons and matter waves - The Schrodinger wave equation - Time-dependent Schrodinger¨equation – Physical meaning and conditions on admissible wave function – Conservation of probability– Expectation value – Ehrenfest′ s theorem – Conditions for allowed transitions - classIcal limit of quantum mechanics.

Operator Formulation: Linear operator – Adjoint and self-adjoint operators – Completeness – Physical interpretation of eigenvalues and eigenfunctions – Commutator – Simultaneous eigenfunctions – Heisenberg uncertainty relation.

UNIT II　　BOUND STATES

Classical probability distribution - free particle - harmonic oscillator - particle in a box - rectangular barrier potential - tunnel effect - quantum pendulum - existence of a bound state - time-dependent harmonic oscillator - rigid rotator.

UNIT III　　PERTURBATION THEORY

Time-independent perturbation theory for non-degenerate states – Application to linear harmonic oscillator with perturbation – eFx and anharmonic oscillator with perturbation x3 and x4 – Perturbation theory for de-generate states – Stark effect in hydrogen atom – Time- dependent perturbation theory: Constant perturbation – Transition probability – Harmonic perturbation - semiclassical theory of radiation.

UNIT IV　　ANGULAR MOMENTUM

Scalar wave function under rotations - Components of orbital angular momentum L – Commutation relations– Ladder operators L± -- Expectation values – Eigenspectra through commutation relations – Properties of eigenvalues of L2 -- Components of spin operator - spin states of an electron - spin-orbit coupling - addition of angular momenta - rotational properties of operators.

UNIT V　　RELATIVISTIC QUANTUM MECHANICS

Klein – Gordon equation for a free particle – Dirac equation for a free particle – Dirac matrices and their properties – Probability and current densities– Plane wave solutions – Negative energy states – Zitterbewegung: jittery motion of a free particle – Spin of a Dirac particle - particle in a potential - Klein paradox - relativistic particle in a box.

REFERENCES

1.L. Schiff, Quantum Mechanics, Tata McGraw Hill, New Delhi, 1968.
2. P. M. Mathews & K. Venkatesan, A Text Book of Quantum Mechanics , Tata McGraw Hill, New Delhi, 1987).
3. S. Rajasekar and R. Velusamy, Quantum Mechanics: The Fundamentals, CRC Press, Boca Raton, 2015.
4. M.S. Rogalski& B. Palmer, Quantum Mechanics , Gordon & Breach, Amsterdam, 1999)
5. Y.B. Band and Y. Avishai, Quantum Mechanics with Applications to Nanotechnology and Information Science, Academic Press, 2013.

SEMESTER-II: CORE 9

ADVANCED PRACTICAL **L T P C**

0 0 6 4

Pre-Requisite: None

OBJECTIVES

1. To make the students to understand experimental physics and electronics
2.To apply the theoretical knowledge for developing new devices

(Analog electronics, optics, laser, condensed matter) - Any fifteen experiments only

1. Generation of simple waveforms using an operational amplifier.
2. Analog computation and solution of simultaneous equations using an op-amp circuit.
3. Construction and assessment of regulated power supplies
4. Characteristics of a silicon controlled rectifier (scr) and firing angle control.
5. Characteristics and applications of a triac.
6. Characteristics of a unijunction transistor (ujt) and ujt as a relaxation oscillator. 7. Triggering of scr by ujt relaxation oscillator.
8. Construction of a stable and monostablemultivibrators using ic ne-555.
9. Characteristics of a metal-oxide semiconductor field-effect transistor (mosfet) and construction of a common-source amplifier.
10. Construction and frequency measurement of series-fed and shunt-fed hartley oscillators.
11. Construction and frequency determination of a crystal oscillator.
12. Construction and analysis of a differential amplifier.
13. Construction and assessment of class b push-pull complementary-pair audio amplifiers.
14. Construction of a phase-locked loop circuit
15. Monochromatic and white interference fringes using a michelson interferometer.
16. Interference fringes using a lummer-gherke plate.
17. Use of fabry-perot etalon to excite interference fringes.
18. Analysis of edser-butler fringes.
19. Analysis of a solar spectrum.
20. Laser – determination of wavelength, thickness of a thin wire/slit width, particle size.
21. Fiber optics – determination of numerical aperture, estimation of loss, audio transmission.
22. Determination of cell parameters from powder xrd pattern.
23. Electrical resistivity measurement by four probe method and band gap determination.
24. Study of the b-h curve of a ferro magnetic material.
25. Determination of curie temperature of a ferro electric material.
26. Photoconductivity

Workshop practice

I) Practices in shaft facing, plain turning, step turning, champering and knurling.
II) Practices in shaft centering and undercut.
III) Technique of shaft radius forming. Iv) drilling practice.

Books for reference

1. Paul b. Zbar, basic electronics - a text-lab manual iii edition tatamcgraw-hillpublishing co. Ltd., new delhi,1979. 2. Lab manuals

SEMESTER-II:CORE ELECTIVE PAPERS

A. ASTROPHYSICS **L T P C**
2 1 0 3

Pre-Requisite: Astrophysics of the Solar System

OBJECTIVES

- To Achieve a good understanding of physical laws andprinciples.
- To Gain experience with measurement techniques and equipment, and develop theability to assess uncertainties and assumptions.

Unit-I Review of radiation physics

Black Body radiation, formation of spectral lines, radiation field, radioactive transfer equation, optical depth, thermodynamic equilibrium, radiative transfer involved in stellar interior, Bramestrahlung, Compton &Phomson scattering.

Unit-II History of Universe

Very early universe, Primordial nucleo synthesis, Baryogenesis, Cosmic neutrino background, Cosmic microwave background, anisotropies in CMBR, galaxies at high red shift, intergalactic medium, Structure formation, matter-antimatter asymmetry in the universe.

Unit-III Solar properties

Over view of Sun, location of Sun, Sun's spectrum, Solar interior structure, energy generation, Radiative tone, convection zone, observing the sun & solar telescopes, solar polarimetry, solar atmosphere, photosphere & active spots, sunspots, solar cycle, active & quiet sun, solar flares, Radio bursts, solar wind.

Unit-IV Stellar Structure

Hydrostatic equilibrium, Mass conservation, luminosity gradient equation, temperature gradient equations, Laue-Eqrden equation for polytrophic stars & its physical solution, Estimates of central pressure & temperature, radiation pressure, equation for temperature gradient for radiative& convective equilibrium, Schuarzchild criterion, gas pressure & radiation pressure: linear model & its properties, Mass luminosity relation.

Unit-V Milky way-galaxy

Counting of stars in the sky, star clusters-globular & open association, historical models, Morphology of the galaxy, different population, mass distribution, estimation of total mass of galaxy, kinematics of the milkyway, differential rotation of the galaxy, Rotational curves, Oort's constants, Galactic centre-Super massive black holes & jets.

Text Books:

1. Erika Bohm-Vitense, Introduction to Stellar Astrophysics, Vol. 3 : Stellar structure and evolution.
2. Herwitt. M., Astrophysical Concepts 3rd Edition, Springer Verlag 2006.
3. L. Spitzer, Physical Processes in the Interstellar Medium, John Wiley & Sons, 2008
4. Bradley W. Carroll & Dale A. Ostlie, An introduction to Modern Astrophysics, Pearson New International Edition

Reference Books :

1. The Physical Universe by Frank Shu, University of California 1982 Sago.
2. M. Schwarzschild: Structure and Evolution of Stars, Dover
3. Theoretical Astrophysics: Vol. III, Galaxies and Cosmology T. Padmanabhan Cambridge University Press, 2005.

SEMESTER II:CORE ELECTIVE PAPER

B. SEMICONDUCTOR PHYSICS **L T P C**

2 1 0 3

Pre-Requisite: Basic of Applied Physics

Objective: To introduce the basic properties of semiconductors and modern devices based on semiconductor materials.

Unit – I: Properties of Semiconductors Crystalline and amorphous semiconductors – band structure – semiconductor in equilibrium – charge carriers in semiconductors – intrinsic Fermi level position – dopant atoms and energy levels - extrinsic semiconductor – statistics of donors and acceptors – charge neutrality – position of Fermi energy level.

Unit – II: Carrier Transport Phenomena Carrier drift – drift current density – mobility effects – conductivity – carrier diffusion – diffusion current density – total current density – graded impurity distribution – induced electric field – Einstein relation – Hall Effect.

Unit – III: Nonequilibrium Excess Carriers Carrier generation and recombination – semiconductor in equilibrium – excess carrier generation and recombination – characteristics of excess carriers – continuity equations – time-dependent diffusion equations – Ambipolar transport – derivation of the Ambipolar transport equation – dielectric relaxation time constant – quasi-Fermi levels.

Unit –IV: The p-n Junction Basic Structure of the p-n Junction – zero applied bias – built-in potential barrier – electric field – space charge width – reverse applied bias – space charge – width and electric field – junction capacitance – one-sided junctions – current – voltage characterization – photo – diodes – avalanche photodiode – semi-conductor lasers – transition process – population inversion – gain junction lasers – threshold current density.

Unit – V: Semiconductor Devices Metal-semiconductor and Semiconductor heterojunctions – Schottky Barrier Diode – metal-semiconductor ohmic contacts – heterojunctions – bipolar transistor – Metal-Oxidesemiconductor Field-Effect Transistor – Junction Field-Effect Transistor – Solar cell-basic characteristics – spectral response – recombination current and series resistance.

Text Books

1. R.A. Smith , Semiconductors, Academic Publishers, Kolkota (1989).

2. Donald A. Neamen, Semiconductor Physics And Devices 4th ed., Tata Mc-Graw Hill (2012).

References Books

1. S.M. Sze and Kwok K. Ng, Physics of Semiconductor Devices, 3rd edn, Wiley (2012).

2. M.S. Tyagi, Introduction to Semiconductor Materials and Devices 1st Ed. John Wiley and Sons (1991).

SEMESTER II:CORE ELECTIVE PAPER

C. COMPUTATIONAL PHYSICS

L T P C
2 1 0 3

Pre-Requisite: To provide knowledge about various mathematical methods.

OBJECTIVE

To improve and enhance the analytical ability in problem solving skills of students using numerical methods.

- To demonstrate the understanding of numerical methods using Mat Lab.
- To solve the large system of linear equations and find the roots of non-linear equations.
- To familiarize interpretation and curve fitting using numerical methods.
- To understand and use the appropriate method of numerical differentiation and integration when the function is too complicated and difficult to solve.
- To demonstrate the use of different methods to find the solution of ordinary differential equation and get exposed to basic statistics.

UNIT I MATLAB/SCILAB PROGRAMMING

Overview of Matlab – data types and variables – operators – flow control – functions – input-output – array manipulation – writing and running programs – plotting – overview of simulink environment.

UNIT II SYSTEM OF EQUATIONS

Linear equations: Introduction – linear systems – Gaussian elimination – singular systems – Jacobi iteration - Gauss-Seidel iteration. Nonlinear equations: Introduction – bisection method – rule of false position – Secant method – Newton-Raphson method – Comparison of methods for a single equation – Seidel and Newton’s methods for systems of nonlinear equations.

UNIT III INTERPOLATION & CURVE FITTING AND ERROR ANALYSIS

Polynomial interpolation theory - Newton's forward and backward interpolation formulae - Lagrange's method - Lagrange's inverse interpolation – piecewise linear interpolation – interpolation with cubic spline – least-squares line - curve fitting – Fourier series and trigonometric polynomials.

UNIT IV NUMERICAL DIFFERENTIATION AND INTEGRATION

Numerical differentiation: Finite difference approximations – Richardson extrapolation – derivatives by interpolation. Numerical integration: introduction to quadrature – composite Trapezoidal and Simpson’s rule – recursive rules and Romberg integration – Gaussian integration.

UNIT V DIFFERENTIAL EQUATIONS SOLVING AND STATISTICS

Initial value problems: Euler method - Taylor series method – Runge-Kutta methods – stability and stiffness – adaptive Runge-Kutta method – Predictor- corrector method – system of differential equations – phase-plane analysis: chaotic differential equations. Boundary value problems:finite-difference method. Statistics: random variable – frequency distribution – expected value, average and mean – variance and standard deviation – covariance and correlation. Generating random numbers – Monte Carlo integration.

REFERENCES

1. A. Kharab and R.B. Guenther. An Introduction to Numerical Methods: A MATLAB Approach. CRC Press, 2018.
2. J. H. Mathews and K. D. Fink. Numerical Methods using MATLAB. Pearson Education India, 2015.
3. C. Woodford and C. Phillips. Numerical Methods with worked examples: MATLAB edition. Springer, 2014.
4. M.K.Venkatraman, Numerical Methods in Science and Engineering. National Publishing Company, Madras, 1997.
5. S.S.Sastry. Introductory Methods of Numerical Analysis. Prentice Hall India Learning Private Limited, 2012.

SEMESTER II: OPEN ELECTIVE PAPERS

A. Materials Characterization

L T P C
2 0 0 2

Pre-Requisite:

The purpose of this lab course is to synthesize different materials in laboratory and characterize those using appropriate analytical techniques.

OBJECTIVE

To introduce the important characterization techniques to the students

- To make the students familiarize with image formation in an optical microscope and learn other specialized microscopic techniques.
- To make the students learn the principle of working of electron microscopes and scanning probe microscopes.
- To introduce the students the basics of some important spectroscopic techniques.

Electron Microscopy & Photoelectron Spectroscopy

Electron Microscopy

UNIT 1:

Introduction: Interaction of electrons with matter – Why electron scattering? – scattering– characteristics of electron scattering – the interaction cross section – the mean free path – the differential cross section – other factors affecting scattering – Fraunhofer and Fresnel diffraction – diffraction of light from slits – coherent interference.

UNIT II:

*Instrumentation:*Electron sources: electron guns - thermionic guns, field emission guns thermionic emission, field emission – characteristics of the electron beam: brightness, temporal coherency and energy spread, spatial coherency and source size, stability – gun characteristics: beam current, convergence angle, calculating the beam - SEM & TEM Instrumentation - Sample preparation.

TEM: Diffraction from small volumes - diffraction from wedge shaped specimens, diffraction from planar defects, diffraction from particles, Diffraction from dislocations– *SAED images:* ring pattern from polycrystalline materials, ring patterns from amorphous materials.

Photoelectron Spectroscopy

UNIT III:

Introduction: Spectroscopic notation, X-ray notation – Atomic model and electron configuration- principle of XPS – principle of AES - charge compensation in XPS.

UNIT IV:

Instrumentation: Electron sources: thermionic emitter, lanthanum hexaborate emitter, cold field emitter, hot field emitter – analyzers: cylindrical mirror analyzers - hemispherical sector analyser – detectors: channel electron multipliers, channel plates.

UNIT V:

Spectral Analysis: Unwanted features in electron spectra, data acquisition – chemical state information – shake-up satellites – multiplet splitting – factors affecting the quantification of XPS spectrum - AES analytical techniques.

Book for Reference:

1. D. B. Williams and C. B. Carter, **Transmission Electron microscopy basics**, Springer, 1996.
2. Yang Leng, **Materials Characterization: Introduction to Microscopic and Spectroscopic Methods**, 2nd Edn. Wiley VCH, Germany
3. Sam Zhang, Lin Li and Ashok Kumar, **Materials Characterization Techniques** , CRC Press.
4. J. F. Watts, **An introduction to surface analysis by Electron Spectroscopy**, Oxford University press, Oxford, 1990.
5. John F. Watts, John Wolstenholme, **An Introduction to Surface Analysis by XPS and AES** , John Wiley & Sons Ltd, 2003.
6. T.A. Carlson, **Photoelectron and Auger Spectroscopy** , Plenum press, 975.

SEMESTER II: OPEN ELECTIVE PAPER

B. DISASTER MANAGEMENTL T P C

2 0 0 2

Pre-Requisite: Basics of Disaster

OBJECTIVE

- Demonstrate A Critical Understanding Of Key Concepts In Disaster Risk Reduction and Humanitarian Response.
- Critically Evaluate Disaster Risk Reduction And Humanitarian Response Policy And Practice From Multiple Perspectives.
- Develop An Understanding Of Standards Of Humanitarian Response And Practical Relevance In Specific Types Of Disasters And Conflict Situations.
- Critically Understand The Strengths And Weaknesses Of Disaster Management Approaches, Planning And Programming In Different Countries, Particularly Their Home Country Or The Countries They Work In.

Unit -I: Introduction

Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Repercussions Of Disasters And Hazards: Economic Damage, Loss Of Human And Animal Life, Destruction Of Ecosystem.

Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-Made Disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

Unit -II: Disaster Prone Areas In India

Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

Unit -III: Disaster Preparedness And Management

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Unit -IV: Risk Assessment

Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And Warning, People's Participation In Risk Assessment. Strategies For Survival.

Unit -V: Disaster Mitigation

Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Book for Reference:

1. R. Nishith, Singh Ak, "Disaster Management In India: Perspectives, Issues And Strategies", New Royal Book Company, Lucknow.
2. Sahni, Pardeep Et Al. (Eds.), "Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., "Disaster AdminastrationAnd Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi.

SEMESTER II: OPEN ELECTIVE PAPER

C. Clean Energy Science

L T P C
2 0 0 2

Pre-Requisite:

The course is an integral part of specializations related to sustainable power generation, sustainable energy utilization, energy policy, and energy systems analysis.

Objective:

The purpose of this course is to provide a survey of the most important clean energy resources and the related technologies for harnessing them, from simple methods to state-of the-art advanced energy systems.

Unit-1:

Global Energy Needs -Current energy status of India - Energy production from differentsources - Hydrothermal - Geothermal - Solar - Renewable/Non-Renewable sources-Environmental impact - Necessity of energy materials.

Unit-2:

Materials for Thermal Power Generation - Environmental Impactof thermal power plants-Improving Efficiency of thermal power plants -Materials challenges in high temperature and pressure of steam.- Thermal Barrier Coating (TBC) over turbines - Materials Compositions for TBC -Yittria stabilized Zirconia and perovskite based compositions.

Unit-3:

Batteries - Types of Batteries- battery mechanism - Electrochemical reactions: Corrosion,oxidation and prevention- Open circuit voltage - theoretical capacity - theoretical specificenergy calculations - Irreversible losses in battery -Testing of a Battery - Lithium PrimaryBattery – Secondary Rechargeable Batteries - Lead Acid Battery - Ni-Cd Battery - Li ionBattery - Recent developments in Batteries - Industrial Testing and Standard procedures for Battery - Fabrication Techniques.

Unit-4:

Fuel Cells, Components of Fuel Cells - types of Fuel Cells - difference between batteries andfuel cells - working of fuel cell - theoretical efficiency - various factors affecting efficiency - calculation of consumption of gases - high temperature - intermediate and low temperature fuel cells - Materials for Solid Oxide Fuel cells -materials for Polymer Electrolyte Fuel Cells - Automobile and stationary power applications.

Unit-5:

Ragone Plot - Supercapacitors - Non-Faradaic/Faradaic - Hybrid type - role of carbonmaterials in Supercapacitors- Photovoltaics -principle of photovoltaic cell – Materialchallenges - perovskites as absorbers - Harvesting of waste heat by thermoelectric materials -Properties of materials to be used for thermoelectric applications.

REFERENCES

1. Series of Articles on “Materials Research Bulletin” 37 (2012) - Thermal Barrier coatings for efficient gas turbine engines
2. Linden D and Reddy Thomas B., Handbook of Batteries, Mc-Graw Hill (2001)
3. A.J.Bard and L.R. Faulkner, Electrochemical Methods: Fundaments and Applications, Wiley 2nd Edition (2000)
4. James Larminie and A. Dicks, Fuel Cells Explained, Wiley 2nd edition (2003)
5. Fuel Cell Handbook by EG&G Technical Services (2004) (e-copy available)
6. Sossina M. Haile, Materials for Fuel Cells, Materials Today (March 2003)
7. Allan J. Jacobson, Materials for solid oxide Fuel Cells, Chemistry of Materials 22, 660 (2010)
8. Green, M. A. Solar Cells: Operating Principles, Technology, and System Applications. Prentice Hall (1981)
9. Bell, Lon E. "Cooling, Heating, Generating Power, and Recovering Waste Heat with Thermoelectric Systems." Science321 (September 12, 2008): 1457-1461

SEMESTER II: COMPULSORY PAPER

HUMAN RIGHTS L T P C

2 1 0 2

Pre-Requisite: Basic of Human Rights

OBJECTIVES

Students will be able to: Understand the premises informing the themes of liberty and freedom from a Human rights

Perspective:

Unit I:

Definition of Human Rights – Nature, Content, Legitimacy and Priority – Theories on Human Rights – Historical Development of Human Rights.

Unit II:

International Human Rights – Prescription and Enforcement upto World War II – Human Rights and the U.N.O. – Universal Declaration of Human Rights – International Covenant on Civil and Political Rights – International Covenant on Economic, Social and Cultural Rights and Optional Protocol.

Unit III:

Human Rights Declarations – U.N. Human Rights Declarations – U.N. Human Commissioner.

Unit IV:

Amnesty International – Human Rights and Helsinki Process – Regional Developments – European Human Rights System – African Human Rights System – International Human Rights in Domestic Courts.

Unit V:

Contemporary Issues on Human Rights: Children's Rights – Women's – Dalit's Rights – Bonded Labour and Wages – Refugees – Capital Punishment - Fundamental Rights in the Indian Constitution- Directive Principles of State Policy – Fundamental Duties – National Human Rights Commission.

References :

1. International Bill of Human Rights, Amnesty International Publication, 1988.
2. Human Rights, Questions and Answers, UNESCO, 1982.
3. Mausice Cranston– What is Human Rights.
4. Desai, A.R. - Violation of Democratic Rights in India.
5. Pandey - Constitutional Law.
6. Timm. R.W. - Working for Justice and Human Rights.
7. Human Rights- A Selected Bibliography, USIS.
8. J.C.Johari - Human Rights and New World Order.
9. G.S. Bajwa - Human Rights in India.
10. Amnesty International- Human Rights in India.
11. P.C.Sinha&K.Cheous [Ed]- International Encyclopedia of Peace, Security Social Justice and Human Rights [Vols 1-7].
12. Devasia, V.V. - Human Rights and Victimology.

Magazines:

1. The Lawyer, Bombay.
2. Human Rights Today, Columbia University.
3. International Instruments of Human Rights, UN Publication.
4. Human Rights Quarterly, John Hopkins University, U.S.A.

SEMESTER-III :CORE 10

QUANTUM MECHANICS - II **L T P C**

3 1 0 4

Pre-Requisite:To studies in Advanced Nuclear Physics andElementary ParticlePhysics

OBJECTIVES

- To introduce the basic concepts of matrix mechanics.
- To make the students to understand different types of approximation methods
- To elucidate the aspects of scattering theory and its importance.
- To introduce the concepts of quantum field theory.
- To make the students to understand the basics of applied quantum systems.

UNIT I MATRIX MECHANICS

Linear vector space - matrix representation of operators and wave function - unitary transformation - tensor products - Schrodinger equation in matrix form - applications - Dirac's BRA and KET notations - properties of BRA and KET vectors - Hilbert space - projection and displacement operators - matrix method for computing stationary state solutions.

UNIT II APPROXIMATION METHODS

Basis-state expansion - Principle of WKB method - applications of WKB method - WKB quantisation with perturbation - asymptotic method .Variational approach: Calculation of ground state energy - trial eigenfunctions for excited states - hydrogen molecule - hydrogen molecule ion - coupling between dissimilar quantum wells - exciton in quantum wells.

UNIT III SCATTERING THEORY

Classical scattering cross-section - centre of mass and laboratory co-ordinates - scattering amplitude - Green's function approach - Born approximation - partial wave analysis - scattering from a square-well system - phase-shift of one-dimensional case - inelastic scattering - alloy scattering. Identical particles: permutation symmetry - symmetric and antisymmetric wave functions - exclusion principle - resonance scattering.

UNIT IV QUANTUM FIELD THEORY

Definition - classical field theory - quantum equations for fields - quantisation of relativistic wave equation - electromagnetic field in vacuum - interaction of charged particle with electromagnetic field - spontaneous emission - quantisation of KG equation - quantisation of Dirac field - Gauge field theories - basics of path integral formulation.

UNIT V QUANTUM WORLD

Two-dimensional infinite well - two-dimensional harmonic oscillator - quantum angular momentum in 2D - circular infinite well - isotropic harmonic oscillator - spherical coordinates and angular momentum - free particle in spherical coordinates - multi electron atoms -. Mesoscopic systems: quantum wells - quantum wires - quantum dots - - Kondo effect in quantum dots - quantum spin Hall effect.

REFERENCES

1. P. M. Mathews & K. Venkatesan, A Text Book of Quantum Mechanics , Tata McGraw Hill, New Delhi, 1987).
2. 2. S. Rajasekar and R. Velusamy, Quantum Mechanics II: Advanced Topics, CRC Press, Boca Raton, 2015.
3. Jasprit Singh, Modern Physics for Engineers, Wiley-VCH, 2004.
4. Y.B. Band and Y. Avishai, Quantum Mechanics with Applications to Nanotechnology and Information Science, Academic Press, 2013.
5. Richard W. Robinett, Quantum Mechanics, Oxford University Press, 2006.

SEMESTER III: CORE 11

XXXXXX **SOLID STATE PHYSICS - I** **L T P C**
3 1 0 4

Pre-Requisite: To give strong foundation in the development of solidstate physics with appropriate theoretical background.

OBJECTIVE

- To understand the basic crystal structures, bonding of solids and the lattice energy calculations.
- To explain electrical and thermal conduction in metals and Fermi distribution function.
- To discuss how our understanding of lattice dynamicsis formulated in terms of travelling waves, together with the role of the interatomic forces.
- To understand the electrons in solid move under the influence of a periodic potentialdue to ions arranged along a periodic lattice. The energy spectrum of such electrons consists of allowed and forbidden energy bands and the theory developed on the basis of this model.
- To study the properties of different Semiconducting materials and superconducting materials and their applications.

UNIT I CRYSTAL STRUCTURE AND BONDING

Crystalline solids - crystal systems - Bravais lattices –coordination number – packing factors – cubic, hexagonal, diamond structure, Sodium Chloride Structure – lattice planes and Miller Indices – interplanar spacing – directions. Types of bonding - lattice energy - Madelung constants – Born Haber cycle – cohesive energy.

UNIT II FREE ELECTRON THEORY

Drude theory – Wiedemann-Franz Law and Lorentz number –Quantum state and degeneracy- density of states, concentration - free electron statistics (Fermi-Dirac), Fermi energy and electronic Specific heat, Electrical resistivity and conductivity of metals – Boltzmann transport theory –- electrical and thermal conductivity of electrons.

UNIT III LATTICE DYNAMICS

Mono atomic and diatomic lattices – anharmonicity and thermal expansion- phonon –Momentum of phonons, Inelastic scattering of photons by long wavelength phonons, Local phonon model – Einstein and Debye model, density of states, Thermal conductivity of solids- due to electron-due to phonons – thermal resistance of solids – phonon-phonon interaction-normal and Umklapp processes - scattering experiments.

UNIT IV PERIODIC POTENTIALS AND ENERGY BANDS

Bloch's theorem – Kronig-Penney model-Construction of Brillouin Zones-Effective mass of electron-nearly free electron model – Tight binding approximation-Construction of Fermi Surfaces-density of states curve-electron, holes and open orbits-Fermi surface studies - Cyclotron resonance – anomalous skin effect –de Hass van Alphen effect.

UNIT V PHYSICS OF SEMICONDUCTORS AND SUPERCONDUCTIVITY

Semiconductors – direct and indirect gaps – carrier statistics (intrinsic and extrinsic) – law of mass action– electrical conductivity and its temperature variation - III - V and II – VI compound semiconductors. Superconductivity – critical parameters – anomalous characteristics – isotope effect, Meissner effect – type I and II superconductors - BCS theory (elementary) - Josephson junctions and tunneling – SQUID - High temperature superconductors - applications.

REFERENCES

1. M.A.Wahab. Solid State Physics: Structure and Properties of Materials. Narosa Publishing House Pvt. Ltd., 2015.
2. M.Ali Omar. Elementary Solid State Physics. Pearson Education, 2002.
3. M.S.Rogalski and S.B.Palmer. Solid State Physics. Gordon Breach Science Publishers, 2000.
4. N.W.Ashcroft and N.D.Mermin. Solid State Physics, Cengage Learning, 2003.
5. A.J Dekker. Solid State Physics. Laxmi Publications, 2008.
6. James D.Patterson and Bernard C.Bailey. Solid-State Physics: Introduction to the Theory. Springer, 2018.

SEMESTER III:CORE 12

THERMODYNAMICS AND STATISTICAL PHYSICS **L T P C**
3 1 0 4

Pre-Requisite: Introduction to thermodynamics, Undergraduate level basics of classical mechanics and quantum mechanics

OBJECTIVE

To understand the concepts of Thermodynamics and statistical mechanics and its applications

UNIT I: Thermodynamics and Basic Concepts

Review of thermodynamics – thermo dynamical laws and consequences – Gibb's free energy and Helmholtz' free energy – Thermo dynamical potential – Phase-space – Density of states – Liouville's theorem – Probability consideration of tossing of distinguishable and indistinguishable coins – General expression for probability of distribution – Stirling's formula – Most probable distribution – Maxwell-Boltzmann's distribution law – Law of equipartition of energy.

UNIT II:Bose-Einstein Statistics

Quantum statistics of identical particles – Density matrix and limitations – Bose-Einstein distribution law – Black body radiation – Planck's radiation law – Specific heat of solids – Einstein theory – Debye's theory – Ideal Bose-Einstein gas – Degeneracy of Bose- Einstein gas – Bose-Einstein Condensation.

UNIT III: Fermi-Dirac Statistics

Fermi-Dirac distribution law – Ideal Fermi-Dirac gas – Fermi energy – degeneracy – Weak degeneracy, strong degeneracy – Electron gas in metals – Thermionic emission of electrons – Specific heat of gases – monoatomic, diatomic and polyatomic gases – variation with temperature.

UNIT IV:Partition Function and Applications

Relation between statistical and thermodynamical quantities – Partition function and thermodynamical quantities Micro canonical, canonical and grand canonical ensembles – Chemical potential – Entropy mixing and Gibbs' paradox – Saucker-Tetrode equation for entropy – Molecular partition function – Translational partition function – rotational and vibrational partition functions and applications.

UNIT V: Applications of Quantum Statistics

Fluctuations in thermodynamical quantities – one dimensional Random walk – Brownian movement – Langevins theory - Fokker Planck equation – solution – Wiener – Khintchine theorem – Phase transition – The Ising model (one, two and three dimensional).

Books for study:

1. F.W. Sears and G. L. Salinger, Thermodynamics, Kinetic theory, and statistical Thermodynamics - Third Edition, NarosaPublishong House, 2011.
2. Kerson Huang, Statistical Mechanics – John Wiley & Sons, Inc., New York, 1987, Second edition.
3. Gupta & Kumar, Statistical Mechanics, 20th edition, PragatiPrakashan Meerut, 2003.
4. B.K. Agarwal and Melvin Eisner - Statistical Mechanics – New Age International (P) Limited, New Delhi, 1998.

Books for references:

1. A.K.Dasgupta – Fundamentals of Statistical Mechanics – New Central Book Agency (P) Ltd., Calcutta, 2000.
2. Sears and Zymanski – Statistical Mechanics – McGraw Hill Book Company, New York, 2011.
3. FederickReif. - Fundamentals of Statistical and thermal Physics – McGraw Hill International Editions, Singapore, 1985
4. R. K. Pathria and Paul D. Beale - Statistical Mechanics – Third edition, Academic Press (2011).

SEMESTER-III:CORE 13

PRACTICAL – NUMERICAL METHODS USING PYTHON **L T P C**
3 1 0 4

Pre-Requisite: None

OBJECTIVES

1. To make the students to understand physics and algorithmic approach
2.To apply the theoretical knowledge for developing new devices

List of Experiments in the Progamming using Python: (Any 15)

1. Determination of root of equation by bisection method
2. Determination of root of equation by Newton Raphson method
3. Determination of all real roots of a quartic/cubic equation by Newton Raphson Method with subroutine subprograms
4. Lagrange interpolation
5. Newton Forward interpolation
6. Newton Backward interpolation
7. Newton Forward interpolation with subroutine subprograms
8. Newton Backward interpolation with subroutine subprograms
9. Maxima and Minima of a tabulated function with subroutine subprograms
10. Maxima and Minima of a gamma function with subroutine subprograms
11. Integration by Trapezoidal rule
12. Integration by Simpson's rule
13. Integration by Gauss-Legendre Quadrature
14. Integration by Gauss-Chebyshev Quadrature
15. Integration by Gauss-Hermite Quadrature
16. Integration by Gauss-Laguerre Quadrature
17. Determination of zeroes of Legendre Polynomials
18. Determination of zeroes of Laguerre Polynomials
19. Determination of zeroes of Hermite Polynomials
20. Determination of zeroes of Chebyshev Polynomials

BOOKS FOR STUDY AND REFERENCE

1. J. B. Scarborough, Solutions of Numerical equations.
2. John H. Mathews, Numerical methods for mathematics, science and engineering.
3. M. K. Venkataraman , Numerical methods in science and engineering.
4. M. K. Jain, S. R. K. Iyengar, R. K. Jain, Numerical methods for scientific and engineering computation.
5. Samual D. Conte and Carl de boor, Elementary Numerical Analysis – An algorithmic approach.

SEMESTER III:CORE ELECTIVE PAPER

A. PYTHON PROGRAMMING

L T P C
2 1 0 3

Pre-Requisite: To provide knowledge about various mathematical methods.

OBJECTIVES

- To introduce the concepts of algorithms and developing them.
- To make the students to understand different types of data,expressions and statements in Python environment.
- To elucidate the aspects of control flow and functions in Python environment.
- To introduce the concepts of lists, tuples and dictionaries in Python environment.

UNIT I ALGORITHMIC PROBLEM SOLVING

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, guess an integer number in a range, Towers of Hanoi.

UNIT II DATA, EXPRESSIONS, STATEMENTS

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments; Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points.

UNIT III CONTROL FLOW, FUNCTIONS

Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Strings: string slices, immutability, string functions and methods, string module; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search.

UNIT IV LISTS, TUPLES, DICTIONARIES

Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters; Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

UNIT V FILES, MODULES, PACKAGES

Files and exception: text files, reading and writing files, format operator; command line arguments, errors and exceptions, handling exceptions, modules, packages; Illustrative programs: word count, copy file.

REFERENCES

1. Kenneth Lambert. Fundamentals of Python: First Programms.
Cengage Learning, 2012.
2. Mark Lutz. Learning Python. O'Reilly Media, 2013.
3. Eric Matthes. Python Crash Course. No Starch Press, 2015.
4. R.Nageswara Rao. Core Python Programming. Dreamtech Press, 2018.
5. Yuxi Liu. Python Machine Learning by Example. Packt Publishing Ltd., 2017.

SEMESTER III: CORE ELECTIVE PAPER

B. NONLINEAR SCIENCE **L T P C**
2 1 0 3

Pre-Requisite: The concepts of electromagnetic theory and refractive index of materials

OBJECTIVE

- To introduce the concept of dynamical systems, phase-space and equilibrium points.
- To make the students to understand the importance of nonlinearity and bifurcations.
- To show the occurrence of chaos in discrete systems and applications.
- To elucidate the notion of fractals and pattern formation in dynamical systems.
- To introduce the concept of solitons in simple nonlinear dynamical systems.

UNIT I DYNAMICAL SYSTEMS

Linear and nonlinear differential equations - Autonomous and nonautonomous systems - Phase trajectories, phase-space, flows and limit sets – Linear systems and linearity principle – Second-order linear equations – Trace-Determinant plane - Classification of equilibrium points in planar systems – Periodic orbits, limit cycles, Poincaré-Bendixson theorem.

UNIT II BIFURCATIONS AND CHAOS

Equilibria in nonlinear systems - bifurcations – Local and global bifurcations - Three dimensional autonomous systems and chaos, Lyapunov exponents -– Torus – quasi-periodic attractor – Poincaré map – Period doubling cascades – Feigenbaum number – characterization – Homoclinic orbits, heteroclinic orbits – Strange attractor and strange non-chaotic attractor. Chaotic Lorenz system, Chaotic Chua's circuit and Chaotic MLC circuit.

UNIT III DISCRETE DYNAMICAL SYSTEMS

Linear and nonlinear discrete dynamics systems – complex iterated maps – Logistic map – Linear stability – Period doubling phenomena and chaos – Lyapunov exponents – Chaos synchronization – Synchronization manifold and stability properties – Controlling of Chaos – applications.

UNIT IV FRACTALS, CELLULAR AUTOMATA AND PATTERN FORMATION

Dimension of regular and chaotic attractors – Fractals – Koch curve – Cantor set – Sierpinski set – Julia and Mandelbrot sets – Cellular automata – Self organized criticality – Stochastic resonance – pattern formation – Time series analysis.

UNIT V INTEGRABLE SYSTEMS AND SOLITONS

Finite dimensional integrable systems - Linear and nonlinear dispersive systems – solitary waves - The Scott Russel phenomenon and derivation of Korteweg-de Vries (KdV) equation – Fermi – Pasta – Ulam (FPU) numerical problem – FPU recurrence phenomenon – Numerical experiments of Zabusky and Kruskal – Explicit soliton solutions: one-, two- and N- soliton solutions of KdV equation – Hirota's bilinear method.

REFERENCES

1. M. Lakshmanan and S. Rajasekar. Nonlinear Dynamics: Integrability Chaos and Patterns. Springer-Verlag, Berlin, 2003.
2. M. Lakshmanan and K. Murali. Chaos in Nonlinear Oscillators. World Scientific, Singapore,1996
3. S. H. Strogatz. Nonlinear Dynamics and Chaos: With Applications to Physics, Biology, Chemistry, and Engineering. Taylor & Francis, 2014.
4. J.M.T.Thompson and H.B.Stewart. Nonlinear Dynamics and Chaos. Wiley, 2013.
5. D.D.Nolte. Introduction to Modern dynamics: Chaos, networks, space and time. Oxford University Press, 2015.

SEMESTER III: CORE ELECTIVE PAPER

C. FIBER OPTIC COMMUNICATION **L T P C**
2 1 0 3

Pre-Requisite: The basic knowledge on advanced laser physics and optic applications.

OBJECTIVES

- To introduce the concepts of optical communication
- To make the students to understand the transmission characteristics of optical fibers
- To educate the students on the aspects of various optical components.
- To impart knowledge on the methods of optical modulation detection
- To introduce the on the concepts of optical fiber communication networks.

UNIT I INTRODUCTION TO OPTICAL COMMUNICATION

Principles of light transmission in fibers - optical fiber modes and configuration - Mode theory for circular wave guides, single mode fibers, Multi – mode fibers, Numerical Aperture, Mode Field Diameter, V-Number - Optical power, polarization, bandwidth and signal quality measurements - Advance fiber design: Dispersion shifted, Dispersion flattened, Dispersion compensating fiber, Design optimization of single mode fibers. Advantages and disadvantages of the optical communication systems.

UNIT II TRANSMISSION CHARACTERISTICS OF OPTICAL FIBERS

Dispersion - Fiber attenuation, absorption loss & scattering loss measurement - Optical Time Domain Reflectometer (OTDR) and its uses - Interferometric method to measure fiber refractive index profile.

UNIT III OPTICAL COMPONENTS

Fiber materials - Fiber fabrication- fiber optic cables design - fiber connectors - fiber splices – optical couplers - Optical sources -LEDs, LASER Diodes, photo detectors - PIN, Avalanche Detectors -- Optical Amplifiers – EDFA, semiconductor and Raman amplifiers.

UNIT IV METHODS OF MODULATION AND DETECTION

Elements of an optical fiber communication system – fiber lasers - Multiplexers - wavelength division multiplexing - Electrooptic and Acoustooptic modulation - Coherent optical fiber communication system - ASK, FSK and PSK modulated waveforms - Basic coherent receiver model - heterodyne and homodyne detections.

UNIT V OPTICAL FIBER COMMUNICATION NETWORKS

Local Area Networks - Bus, ring and star topologies - optical fiber regenerative repeater - optical amplifiers - basic applications - Low speed industrial optical fiber networks – principles of WDM – passive components – Couplers – Multiplexing and De-multiplexing.

REFERENCES:

D. J.C.Palais, Fiber Optic Communications, Pearson, 2005.
E. John M. Senior, Optical Fiber Communications: Principles and Practice, Pearson, 2010.
F. Govind P. Agrawal, Fiber Optic Communication Systems, John Wiley & Sons Inc., New York, 2012.
G. Gerd Keiser, Optical fiber Communications, Tata-McGraw-Hill, 2008.
H. Sudhir Warier, The ABC's of Fiber Optic Communication, Artech House, 2017

SEMESTER III: OPEN ELECTIVE PAPER

A. BASIS OF RENEWABLE ENERGY SOURCESL T P C

20 0 2

Pre-Requisite: Basics of Energy

OBJECTIVES

- To understand the Sources of Energy.
- To understand the various energy resources.
- To understand the importance and economic aspects of energy resources

Unit I: Introduction to Energy Sources:

Conventional energy sources: coal – oil – agricultural and organic waste – water power – nuclear power – new energy technologies. Non convensional energy sources: solar – wind – bio mass and bio gas – ocean thermal energy- tidal energy – hydrogen energy- fuel cells.

Unit II: Solar energy:

Basis of solar energy – solar radiation and its measurement – solar energy collector – solar energy storage – applications of solar energy.

Unit III: Wind energy:

Basic principles of wind energy conversion- the nature of the wind – the power of the wind – maximum power – wind energy conversion – basic components of wind energy conversion systems.

Unit IV: Bio mass energy:

Basis of bio mass energy - bio mass conversion – technologies – wet process – dry process – photosynthesis. Bio gas plants – classification –plants in India- methods of obtaining energy from bio mass.

Unit V: Additional alternate energy sources:

Geothermal energy sources – energy from ocean – chemical energy sources- hydrogen energy – magneto hydrodynamic – thermo electric power.

References:

1. G. D. Rai, Non - Conventional Energy Sources, Khanna Publishers, New Delhi, Fifth Edition, 2012.
2. T. N. Veziroglu, Alternate Energy Sources, Vol.6, McGraw –Hill, 1978.
3. Godfrey Boyle, Renewable Energy: Power for a sustainable Future, Alden Oess Limited – Oxford, 1996.
4. S. P. Sukhatmeand, J. K. Nayak, Solar Energy - Principles of Thermal Collection and Storage, Tata McGraw Hill - Tata, 2008.
5. S. A. Abbasi and NasemaAbbasi, Renewable Energy sources and their environmental impact, PHI Learning Pvt. Ltd., New Delhi, 2008.
6. D. P. Kothari, K. C. Singal&RakeshRanjan, Renewable energy sources and emerging Technologies, Prentice Hall of India pvt. Ltd., New Delhi, 2008.

SEMESTER III: OPEN ELECTIVE PAPER

B. INTELLECTUAL PROPERTY AND PATENTING

L T P C
2 0 0 2

Pre-Requisite: Basic of Patents

OBJECTIVES:

The Objective Of This Course Is To Provide In-Depth Knowledge Of The Laws And Process Related To Trademarks, Copyrights And Other Forms Of Ips With Focus On Patents, The Indian And International Patent Filing Procedure, Drafting Patent Application And Conducting Prior Art Searches. Students Will Be Exposed To The Technical, Management And Legal Aspects Of Ip And Patents.

Unit I: Introduction:

Historical And Philosophical Background Of Patents And Other Intellectual Property, Patent System: The Constitution, Congress, Patent Office (Pto), And Courts; Analyzing And Understanding Judicial Opinions

UnitII: Comparative Overview Of Patents, Copyrights, Trade Secrets, And Trademarks:

Legal Fundamentals Of Patent Protection For Useful Inventions, Design And Plant Patents, Legal Fundamentals Of Copyright Protection, Similarity And Access, Expression Vs. Ideas And Information, Merger, Fair Use Of Copyrighted Works (E.G., For Classroom Use).

Unit III:Copyrights, Trade Secrets, And Trademarks:

Contributory Copyright Infringement, Critical Differences Between Patent And Copyright Protection, Copyright Infringement Distinguished From Plagiarism, Legal Fundamentals Of Trade-Secret Protection, Legal Fundamentals Of Trademark Protection.

Unit IV: Requirements And Limitations Of Patentability: New And Useful:

(A) The Legal Requirement Of Novelty (B) First To Invent Vs. First Inventor To File, The Legal Requirement Of Non-Obviousness.

Unit V: The Process Of Applying For A Patent ("Patent Prosecution"):

Anatomy Of A Patent Application, Adequate Disclosure, The Art Of Drafting Patent Claims, Patent Searching: (A) Purposes And Techniques, Actions For Patent Infringement, Interpretation Of Claims, Doctrine Of Equivalents, Product Testing As A Possibly Infringing Use, Doctrine Of Exhaustion

SUGGESTED READING

Rines, Robert H., “Create or Perish: The Case for Inventions and Patents”, Acropolis, Prelim.

SEMESTER III:OPEN ELECTIVE PAPER

C. NANOMATERIALS AND ITS APPLICATIONS

L T P C

2 0 0 2

Pre-Requisite: The basic aspects of preparation of nanomaterials and their relatedcharacterization techniques.

OBJECTIVES:

To Enable The Students To Understand The Concepts of Nanomaterials And Improve Their Knowledge In Synthesis Methods And Characterization For Further Advanced Research Studies.

Unit-I: Introduction to Nanomaterials

Overview of Nanotechnology, Quantum effect, Nanotechnology in nature. Properties: Physical (Optical, mechanical, dielelectric, photocatalytic, magnetic properties), Chemical and biological properties of nanomaterials, Effects on structure, ionization potential, melting point, and heat capacity, Electronic structure at nanoscale, Magnetism at Nanoscale.

Unit-II: Types of Nanomaterials

Carbon based materials (nanotubes and fullerene), metal based materials (quantum dots, nanogold, metal oxide), Nanocomposites, nanoporous materials and Dendrimers

Unit-III:Nanomaterials Synthesis

CVD, PVD, Molecular beam epitaxy, Vapor (solution) liquid-solid growth (VLS or SLS), mechanical milling, Inert gas condensation technique, spray pyrolysis, lithography technique.

Unit-IV: Characterization Techniques

(Structural, Morphological and Thermal studies): X-ray diffraction (XRD): (Powder and single crystal diffraction), Thermal analysis (DTA-TGA), Spectroscopic studies(FTIR and NMR), Microscopic studies(SEM,TEM and AFM)

Unit-V:Nanomaterials Applications

Energy storage and generation, Molecular Electronics and Nanoelectronics,, Nanosensors, Catalysts, Biological Applications, Carbon Nanotube, Nanophotonics, Green nanotechnology.

Text Books:

1. Charles P. Poole and Frank J. Owens, “Introduction to Nanotechnology”, John Wiley and Sons, New Delhi, 2003.
2. Cao Guozhong, “Nanostructures and nanomaterials: Synthesis, properties and applications”, Imperial college press, 2007.
3. Carl.C.Koch, “Nanostructured materials, processing, properties and applications, NFL publications, 2007.
4. C.N.R.Rao, P.J.Thomas and U.KulkarniNanomaterials: Synthesis, properties and applications, Springer Verlag(2007).
5. Guozhong Cao, Ying Wang, Nanostructures and Nanomaterials, 2nd Edison, Imperial College Press in 2004,USA.
6. Zhen Guo, Li Tan, Fundamentals and Applications of Nanomaterials, Artech house, 2009

SEMESTER-III

MOOCS COURSES:

As per the academic regulations

SEMESTER-III

Field Study and USRR (University Social Responsibility Report)

The aim of the Field Study is to help students connect with the society in the respective discipline. Following are the important features of the Field Study and the USRR:

1. Aim: The Field Study must aim at relating the subject of study with the society in so far as the application and the usefulness of the study are concerned

2. Topic selection: The topic for the Field Study must be chosen by the student in the second semester in the month of February; the process for the same shall begin on 1st February and shall end on the last working day of the month of February. Students are free to select the topic for the Field Study in consultation with the Experts and Faculty Members of their choice, both from within and outside the University

3. Period and duration: The Field Study shall be undertaken for a duration of 15 days in the summer vacation that falls immediately at the end of the second semester of the program and the same should be accounted for the Third Semester of the program

4. USRR: The USSR (University Social Responsibility Report) must be prepared by every student of the program written in 50 to 75 pages. The report shall be written based on the standard research methodology.

5. Review and evaluation schedule:

a. Reviewing the Field work: First week of July

b. Report Review: Second week of August

c. Report submission: First week of September

d. Report Evaluation: Third week of September

6. Faculty Composition: The following Committee Members may be nominated for confirming the topic and for evaluating the USRR:

a. Head of the concerned Department: **Convener**

b. Faculty in-charge of the Department: **Member**

c. Staff of the institute where the candidate as proposed to work: **Member**

SEMESTER IV:CORE 14

SPECTROSCOPY **L T P C**
3 1 0 4

Pre-Requisite: To educate scientifically the principles of EM radiation and significance of various techniques.

OBJECTIVES:

To give advanced knowledge about the interactions of EM radiation with matter andtheir applications in spectroscopy like IR, RAMAN, NMR, ESR, NQR andMossbauerspectroscopy.

Unit-I: Microwave and Infrared Spectroscopy

Microwave spectroscopy – Rotational spectra of diatomic and polyatomic molecules – Symmetric and asymmetric molecules – Techniques and instrumentation – Hyperfine structure and quadruple moment of linear molecules - Experimental techniques - Molecular structure determination Infrared - spectroscopy – Vibrational study of diatomic molecules – Simple gaseous polyatomic molecules – Vibrational frequencies and qualitative analysis – Quantitative IR analysis –Determination of bond moment and bond length – Detection of interstellar atoms and molecules – IR spectrometer – Elementary ideas of FTIR.

Unit-II: Vibrational Raman Spectroscopy

Raman effect – Raman shift – Definitions – Observation of Raman spectra – Raman spectrometer- Quantum theory of Raman effect – Probability of energy transition in Raman effect - Vibrational Raman spectra – Structure determination from Raman and IR Spectroscopy – Coherent anti-Stokes Raman Spectroscopy - Applications of infrared and Raman spectroscopy in molecular structural confirmation of water and CO_2 molecules - Laser Raman Spectroscopy-General features of electronic spectra of diatomic molecules – Frank-Condon principles – Electronic states – Configuration of some typical molecules.

Unit-III: NMR and NQR Spectroscopy

Nuclear Magnetic Resonance Spectroscopy: General principles of NMR - Quantum theory of NMR - design of CW NMR spectrometer - chemical shift - application of chemical shift to molecular structure Bloch equations - Theory of chemical shifts - Experimental methods -Nuclear quadrupole resonance spectroscopy - Definition of Nuclear quadrupole -moment - asymmetry parameter- Integral spins - Fundamental requirements of NQR- spectroscopy - Block diagrams of NQR Spin spectrometer-continuous wave oscillators-principle of super regenerative oscillators - pulsed RF detector - Application of NQR with special reference to chemical bonding.

Unit-IV: ESR Spectroscopy.

Origin of electron spin resonance and resonance condition – Thermal equilibrium and relaxation – Quantum mechanical theory of ESR – Representation of ESR spectrometer –Requirements of ESR spectrometer – Block diagram of a simple ESR spectrometer – Hyper fine structure splitting in isotropic systems involving more than one nucleus – contributions to hyperfine coupling – ESR of triplet states – application of ESR to Solid State Physics (crystal defects) Biological applications.

Unit-IV: Mossbauer Spectroscopy

Principle of Mossbauer Effect –Recoilless emission and absorption – Mossbauer spectrometer – schematic (basic) arrangement – principle of detecting Mossbauer absorption(nuclear volume effect) signal – chemical isomer shift – Theories and interpretation. Electric quadrupole interactions – magnetic interactions – Applications of Mossbauer with special reference to molecular structure, geometrical isomerism, oxidation states and magnetic ordering – geological and biological applications.

Books for Study:

1. C.N. Banwell, E.M. Mc Cash, Fundamentals of Molecular Spectroscopy, 4th Edition, Tata McGraw-Hill Publications, New Delhi, 1994.
2. G. Aruldas, Molecular Structure and Spectroscopy, Prentice - Hall of India Pvt.Ltd., New Delhi, 2001.
3. D.N. Satyanarayana, Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi, 2004.
4. Raymond Chang, Basic Principles of Spectroscopy, McGraw-Hill Kogakusha, 1980.

Books for Reference:

1. Straughn and Walker, Spectroscopy, Vol I &II Chapman and Hall, 1967.
2. Atta Ur Rahman, Nuclear Magnetic Resonance, SpingerVerlag, New York, 1986.
3. Towne and Schawlow, Microwave Spectroscopy, McGraw-Hill, New York, 1995.
4. Raymond Chang, Basic Principles of Spectroscopy, McGraw-Hill, Kogakusha, Tokyo, 1980.

5. D.A. Lang, Raman Spectroscopy, McGraw-Hill International, New York.
6. John Ferraro, Introductory Raman Spectroscopy, Academic Press, New York, 2008.
7. Raj kumar, Atomic and Molecular Spectra: Laser, KedarNath Ram Nath, Meerut, New Delhi, 2015.

SEMESTER IV:CORE 15

NUCLEAR AND PARTICLE PHYSICS **L T P C**
3 1 0 4

Pre-Requisite: Classical and Quantum Mechanics

OBJECTIVE

1.To know the basic properties of nucleus and visualize the characteristics
2. To Understand the fundamentals of shell model and the necessity of nuclear models
3. To know the standard particle model and nuclear synthesis of elements in stars

UNIT I: Nuclear Interactions

Nuclear forces – Exchange forces - Two body problem – Ground state of deutron - Magnetic moment – Quardrupole moment - Tensor forces – Nucleon – Nucleon interaction –Meson theory of nuclear forces and Yukawa's potential - exchange forces- non-central forces- theory of ground state of deuteron. – Nucleon-Nucleon scattering – Effective range theory – Spin dependence of nuclear forces – Charge independence and charge symmetry of nuclear forces – Isospin formalism.

UNIT II: Nuclear Reactions

Types of reactions and conservation laws – Energetics of nuclear reactions –Dynamics of nuclear reactions – Q-value equation – Scattering and reaction cross sections – Wu-Ambler experiment, helicity of electron and of neutrino; introduction to nuclear reactions: Compound nucleus reactions – Direct reactions – Resonance scattering – Breit-Wigner one level formula.

Unit- III

Nuclear detector sand Nuclear electronics

Nuclear detectors: Scintillation Detectors-NaI(Tl), Scintillation spectrometer, Semiconductor detectors: Surface barrier detectors, Li ion drifted detectors, relation between the applied voltage and the depletion region in junction detectors.

Nuclear electronics: Preamplifiers: voltage and charge sensitive preamplifiers, Linearpulseamplifier, Schmitt trigger as a discriminator, differential (single channel analyzer) &integraldiscriminators, Analog to digital converters (ADC), multichannel analyzer (MCA): functionalblock diagram and its working and use in data processing.

UNIT IV: Nuclear Models and Nuclear Decay

Liquid drop model – Bohr-Wheeler theory of fission – Experimental evidence for shell effects – Shell model – Spin-orbit coupling - Magic numbers – Angular momenta and parities of nuclear ground states – Qualitative discussion and estimate of transition rates – Magnetic moments and Schmidt lines – Collective model of Bohr and Mottelson - Beta decay – Fermi theory of beta decay – Shape of the beta spectrum – Total decay rate - Mass of the neutrino – Angular momentum and parity selection rules - Gamma decay – Multipole transitions in nuclei – Angular momentum and parity selection rules – Internal conversion – Nuclear isomerism.

UNIT V: Elementary Particle Physics

Classification of elementay particles - Fundamental particle interactions -Conservation laws - CP and CPT invariance - CP violation in neutral K-decay, hyper nuclei-strangeness and associated production - Gell-Mann-Nishijima formula - Gellmann-okubo mass formula.Quark model, flavours and colours - Isospin and SU(2) symmetry - Eight-fold way and supermultiples- SU(3) symmetry schemes for boson octet, baryon octet and baryon decuplet - Quark model- Types of quarks.

Text Books and References:

Books for study:

1. K. S. Krane, Introductory Nuclear Physics, Wiley, New York, 1987.
2. D. Griffiths, Introduction to Elementary Particle Physics, Harper & Row, New York, 1987.
3. R. R. Roy and B.P. Nigam, Nuclear Physics, New age Intl. New Delhi, 1983.
4. M.L. Pandya and R.P.S. Yadav, Elements of Nuclear Physics 7th Edition, KedarNath Ram Nath, Delhi, 1995.
5. D.C. Tayal, Nuclear Physics, 5th Edition, Himalaya Publishing House, Bombay, 1997.
6. R. C. Sharma, Nuclear physics, KedarNath& Co, Meerut.

Books for reference:

1. H. A. Enge, Introduction to Nuclear Physics, Addison-Wesley, Tokyo, 1983.

2. Y. R. Waghmare, Introductory Nuclear, Physics, Oxford-IBH, New Delhi, 1981.
3. Ghoshal, Atomic and Nuclear Physics, Vol. 2
4. J. M. Longo, Elementary particles, McGraw-Hill, New York, 1971.
5. R. D. Evans, Atomic Nucleus, McGraw-Hill, New York, 1955.
6. I. Kaplan, Nuclear Physics, Narosa, New Delhi, 1989.
7. Nuclear Radiation Detectors, S.S. Kapoor and V.S. Ramamurthy: Wiley-Eastern, New Delhi, 1986. Nuclear Interaction, S. de Benedetti: John Wiley, New York, 1964.
8. Nuclear Radiation Detection, W.J. Price: McGraw Hill, New York, 1964.
9. Elementary Particles, J. M. Longo, II Edition, McGraw-Hill, New York, 1973.
10. Introduction to Nuclear Physics, Wong, PHI

SEMESTER IV:CORE 16

SOLID STATE PHYSICS - II **L T P C**

3 1 0 4

Pre-Requisite: To develop analytical thinking to understand the phenomenon that decides various Properties of solids thereby equip students to pursue higher learningconfidently.

OBJECTIVE

To impart knowledge on various properties of materials

- To introduce the concepts of various mechanical test and plastic deformation the students.
- To introduce the students about various dielectric materials and their application.
- To expose the students to different types of magnetic materials and their properties. The various applications used in magnetic materials.
- To study the properties of various optical materials, LED and LCD and their applications.

UNIT I MECHANICAL PROPERTIES

Plastic deformation by slip – the shear strength of perfect and real crystals -dislocation movement – methods of strengthening against plastic yield – Creep – mechanisms – fracture – ductile fracture – brittle fracture – Griffith criterion – fracture toughness – fatigue fracture - mechanical tests - tensile, hardness and creep tests.

UNIT II DIELECTRIC PROPERTIES

Dielectric constant and polarizability - different kinds of polarization - Internal electric field in a dielectric -Clausius- Mossotti equation - dielectric in a ac field - dielectric loss - ferroelectric - types and models of ferro electric transition - electrets and their applications – piezoelectric and pyroelectric materials.

UNIT III MAGNETIC PROPERTIES

Classification of magnetic materials- origin of magnetism – Langevin and Weiss theories - exchange interaction - magnetic anisotropy - magnetic domains - molecular theory – hysterisis - hard and soft magnetic materials - ferrite structure and uses - magnetic bubbles - magnetoresistance - GMR materials - dilute magnetic semiconductor (DMS) materials.

UNIT IV OPTICAL PROPERTIES

Optical absorption in insulators, semiconductors and metals – band to band absorption – luminescence - photoconductivity. Injection luminescence and LEDs - LED materials - superluminescent LED materials - liquid crystals - properties and structure - liquid crystal displays- comparison between LED and LC displays.

UNIT V ADVANCED MATERIALS

Metallic glasses - preparation, properties and applications - SMART materials - piezoelectric, magnetostrictive, electrostrictive materials - shape memory alloys - rheological fluids - CCD device materials and applications - solar cell materials (single crystalline, amorphous and thin films) - surface acoustic wave and sonar transducer materials and applications - introduction to nanoscale materials and their properties.

REFERENCES

1. V.Raghavan, Materials Science and Engineering: A First Course. PHI Learning, 2015.
2. S.O.Kasap. Principles of Electronic Materials and Devices. McGraw-Hill Education, 2017.
3. C.Suryanarayana and A.Inoue. Bulk Metallic Glasses, CRC Press, 2017.
4. K.Otsuka and C.M.Wayman. Shape Memory Materials, Cambridge University Press, 1998.

SEMESTER IV:

CORE 17 **PROJECT AND VIVAVOCE** **0 0 0 6**

Pre-Requisite:As per the academic regulations

SEMESTER IV: CORE ELECTIVE PAPER

A. NANO SCIENCE **L T P C**
2 1 0 3

Pre-Requisite: The students understand the structure and properties of nanomaterial Physics.

OBJECTIVE:

Nano Sciences, the emerging area of science brings together physics, chemistry and biology to create a scientific discipline of almost infinite potential. Physics of nano materials is concerned with the study, creation, manipulation and applications of materials at nanometer scale.

Unit – I: Special Nanomaterials

Introduction – History of nanotechnology - Classification of nanomaterials: Definition of – Zero, one and two dimension nano structures – Examples - Classification of synthesis methods. Surface energy – Chemical potential as a function of surface curvature – Carbon Fullerenes and Nanotubes: Carbon fullerenes - Fullerene derived crystals - Carbon nanotubes - Micro and Mesoporous Materials: Ordered mesoporous structures - Random mesoporous structures - crystalline microporous materials - Core-shell structures: Metal-oxide structures - Metal-polymer structures, Oxide-polymer structures. Organic-Inorganic Hybrids. Intercalation Compounds – Nanocomposites.

Unit – IV: Synthesis Nanomaterials

Synthesis of nano materials: Physical vapour deposition - Chemical vapour deposition plasma arching - Sol gel - Ball milling technique - Reverse miceller technique - Electro deposition - Synthesis of Semiconductors: Nanostructures fabrication by physical techniques – Nano lithography – Nanomanipulator - Etching technologies: wet and dry etching - photolithography – Drawbacks of optical lithography for nanofabrication - electron beam lithography – ion beam lithography - dip-pen nanolithography.

UNIT –III: QUANTUM DOTS

Quantum confinement - Excitons and excitonic Bohr radius – difference between nanoparticles and quantum dots - Preparation through colloidal methods - Epitaxial methods- MOCVD and MBE growth of quantum dots - current-voltage characteristics - magneto tunneling measurements - Absorption and emission spectra of quantum dots - photo luminescence spectrum.

UNIT IV:PROPERTIESCHARACTERIZATION

Physical properties of nanomaterials: Melting points - Specific heat capacity and lattice constants – Mechanical properties – Optical properties: Surface Plasmon Resonance – Quantum size effects – Electrical property: Surface scattering - charge of electronic structure - Quantum transport - effect of microstructure: Nano SEM - Scanning Conducting microscopy (SCM) - High-resolution Transmission Electron Microscopy (HRTEM) - single nanoparticle characterization –Scanning capacitance microscopy. Chemical Characterization: Optical spectroscopy.

UNIT V: APPLICATIONS OF NANOTECHNOLOGY:

Nanodiodes, Nanoswitches, molecular switches, Nano-logic elements - Single electron transistors - small metallic tunnel junctions - nanoparticles based solar cells and quantum dots based white LEDs – CNT based transistors –Surface acoustic wave (SAW) devices, microwave MEMS, field emission display devices, - Super hard nanocomposite coatings and applications in tooling - Biochemistry and medical applications: lab-on-a-chip systems. Nanoboat –nanosubmarines - DNA engineering. Applications: Molecular electronics and Nano electronics, Nano electromechanical systems- Colorants and pigments –DNA chips – DNA array devices – Drug delivery systems.

Books for study:

2. S. Shanmugam,Nanotechnology TBH Edition.
3. T. Praddetp, Nano- the essential, Mcgraw hill education, Chennai.
4. De Jongh J, Physics and Chemistry of Metal cluster components, Kulwer academic publishers, Dordrecht, 1994.
5. enneth J. Klabunde, Nanoscale Materials in Chemistry, KWiley& Sons, Publcn, 2001.
6. Dexler E, Nanosystems, John Wiley, CNY, 1992.
7. SulabhaK.Kulkarni, Nanotechnology: Principles and Practices, Capital Publishing company.
8. M.A.Shah, Principles of Nanoscience and Nanotechnology, Tokeer Ahmad.

Books for references:

1. Nanotechnology, AIP Press, Springer-Verlag, Gregory Timp editor, New York, , 1999.
2. N. JohnDinardo, Nanoscale characterization of surfaces & interfaces, 2nd Edition, Weinheim Cambridge: Wiley-VCH, 2000
3. Jan Korvink& Andreas Greiner, Semiconductors for micro and nanotechnology-An introduction for engineers, Weinheim Cambridge: Wiley-VCH, 2001.
4. W. Kamliuet. alNanomaterials and mechanics, John Wiley.
5. Hand Book of Nanosciene, Engineering and Technology – The Electrical Engineering handbook series.
6. Nanoscale Materials in Chemistry, Kenneth F. Klablunde, John wiley and sons, Inc., 2001.
7 The Essentials, Pradeep T, Nano: Tata MC Graw-Hill publishing company limited, 2007.
8 Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer, Chad A. Mirkin, 2004.
9 Nanotechnology, Wilson M, K Kannangara, G. Smilt, M. Simmons and B. Boguse- Overseas Press, 2005
10 Nanomedicine, Freitas R A, Landes., TX publication, 1996.
11 Nano Materials, Viswanathan B, Narosa publishing house, 2010.

SEMESTER IV: CORE ELECTIVE PAPER

B. RADIATION AND DETECTOR TECHNIQUES L T P C
2 1 0 3

Pre-Requisite: Broad knowledge in radiation and Detector

OBJECTIVES

To provide the student about the action of radiation and Detector evaluation.

UNIT 1.INTERACTION OF NUCLEAR RADIATION WITH MATTER: Interaction of charged particles and Radiation with matter - Photon interactions with matter – Mechanism of charge production in detector media.

UNIT 2. **GAS FILLED IONIZATION DETECTORS:** Features governing behaviour of Gas Ionization Detectors - Ionization Chambers - Proportional Counters - Geiger Muller Counters.

UNIT 3.SEMICONDUCOR DETECTORS: Interaction of Radiation with Silicon and Germanium - Semiconductor Properties - Physics of Semiconductor Detectors - lon-Implanted Detectors - Position Sensitive Detectors - Anger camera - High purity germanium detectors - X-ray and gamma ray semiconductor detector spectrometers - Semiconductor detector applications - Particle Identification - X-ray spectroscopy - Compound semiconductor detectors - CdTe detectors - Hgl2 detectors.

UNIT 4.SCINTILLATION DETECTORS: Scintillation mechanism and classification of materials - Mechanism of scintillation in Inorganic and Organic scintillators - Noble Gas scintillators - Factors affecting the performance of scintillation detectors - Detection efficiency of scintillation detectors - Photomultiplier tubes, channel electron multipliers and microchannel plates - Gamma ray spectrometry with NaI(Ti) detectors and BF3 counters.

UNIT 5.NUCLEAR ELECTRONIC INSTRUMENT: Detector bias supply - Delay Amplifiers PreAmplifiers -Linear Amplifier -Fast/Slow coincidence circuit - Universal coincidence Circuit - Delay generators - Pulse generators - Pulse amplifier -Pulse height, shapes and rise time for different detectors – Pulse shape discrimination - Pulse height analysis - Pulse height resolution and time resolution - Constant fraction discriminators - Time to amplitude converters - Fine gain and Offset control amplifiers -Single channel analyser - Multichannel devices for pulse height analysis - Nuclear ADC's - Counters and Timers – Contamination, Environmental and Area Monitors - Count rate meter.

BOOKS FOR STUDY

1. W. J. Price, Nuclear Radiation Detectors, McGraw-Hill.
2. S. S. Kapoor and V. S. Ramamurthy - Nuclear Radiation Detectors, Wiley Eastern Limited.
3. Nicholson - Nuclear Electronics.
4. Dearnaley and D. C. Northrop, Semiconductor Counters for Nuclear Radiation.

BOOKS FOR REFERENCE

1. J. M. Taylor, Semiconductors particle detectors, Butterworth.
2. B. Rossi and H. H. Staub, Ionization chambers and counters.
3. J. B. Birks, Scintillation counters.
4. A. K. Shell, Nuclear Instruments and their uses, John Wiley.

SEMESTER IV: CORE ELECTIVE PAPER

C.ENERGY STORAGE DEVICES **L T P C**
2 1 0 3

Pre-Requisite: Fundamentals of Energy Physics

OBJECTIVES

This course helps the student to impart the basic knowledge about fundamentals of energy storage and its significance, various types of energy storage and principles of energy storage devices.

UNIT I: Need of energy storage and different modes of energy storage

Significance of energy storage – Mechanical energy storage - Pumped hydro storage - Compressed gas system - Flywheel storage - Electrical and magnetic energy storage - Chemical Energy storage – Thermal energy storage - Hydrogen for energy storage - Solar Ponds for energy storage.

UNIT II: Chemical energy storage and hydrogen storage

Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical, electro-chemical, fossil fuels and synthetic fuels.

Physics of Hydrogen Storage: Fundamentals - Hydrogen Storage in Bulk and Nanomaterials - Metal Hydrides, Metallic Alloy Hydrides, Carbon Nanotubes.

UNIT IV: Battery

Electrochemical cell and cell reaction - Fundamental laws- General terms and characteristic - Battery Parameters - General terms and Characteristics- General Aspects of Electrochemical Energy Storage- Fundamental Aspects of existing battery systems.

UNIT III: Fuel cell basics

Fuel Cells – Types of Fuel Cells and its Components – Principles of Fuel Cells - Difference Between Batteries and Fuel Cells - Fuel Cell Thermodynamics - Heat, Work Potentials, Prediction of Reversible Voltage, Reduction and Oxidation - Fuel Cell Efficiency - Problems with Fuel Cells - Applications of Fuel Cells.

UNIT V: Super capacitor

Fundamentals of Electric Capacitor- Types and structure of Capacitor – Components and Materials for Electrochemical super capacitor- Electrochemical Super Capacitor Design- Fabricating – operations - Applications of Electrochemical Super Capacitor –Battery Enhancement.

Textbooks:

1. G. D. Rai, Non-conventional energy sources, Khanna Publishers, New Delhi, 2009.
2. Johannes Jensen Bent Squrensen, “Fundamentals of Energy Storage”, John Wiley, NY, 1984.
3. S. P. Sukhatme, Solar energy principles of thermal collection and storage, Tata McGraw- Hill Book Company, New Delhi, 1984.
4. N. K. Bansal, M. Kleemann and M. Melinn, Renewable energy sources and conversion technology, Tata McGraw- Hill Book Company, New Delhi, 1989.

References:

1. R.P. O'Hayre, S. Cha, W. Colella, F.B. Prinz: Fuel Cell Fundamentals, John Wiley & Sons, Inc, New Jersy, 2006.
2. A.J. Bard, L. R. Faulkner: Electrochemical Methods, John Wiley & Sons, Inc, New Jersy, 2004.
3. S Srinivasan, “Fuel Cells: From Fundamentals to Applications”, Springer 2006
4. O’Hayre, SW Cha, W Colella and FB Prinz, “Fuel Cell Fundamentals”, Wiley, 2005