MAR IVANIOS COLLEGE (AUTONOMOUS)

Affiliated to the University of Kerala, Thiruvananthapuram, Kerala

CURRICULUM FOR POSTGRADUATE PROGRAMME

MASTER OF SCIENCE IN PHYSICS

(With effect from 2021 Admissions)

Approved by the Board of Studies in Physics

MAR IVANIOS COLLEGE (AUTONOMOUS), THIRUVANANTHAPURAM
BOARD OF STUDIES IN PHYSICS 2020–2022

Category No.	Name	Designation/Office with Phone no. and e-mail id	Category and Guidelines
a)	Dr.Jijimon K Thomas	Chairperson Associate Professor and Head Department of Physics Mar Ivanios College (Autonomous) 9447205190 jijimon.thomas@mic.ac.in	The senior most HoD of the subjects covered (Associate Professor or above with PhD). If not, an Associate Professor or above with PhD in any of the subjects covered, nominated by the Principal. The Principal shall while nominating teachers, give prime consideration to the quality of academic work including research and publications.
b)	Dr. Annamma John	Associate Professor Department of Physics Mar Ivanios College (Autonomous) 9495244175 annamma.john@mic.ac.in	Not more than 6 teachers (with PhD) in the subjects, nominated by the Principal in consultation with the HOD, from different areas of specialization, as identified by the Principal. The Principal shall, while nominating teachers, give prime consideration to the quality of academic work including research and publications.
	Dr. John Jacob	Assistant Professor Department of Physics Mar Ivanios College (Autonomous) 9447342941 john.jacob@mic.ac.in	
	Dr. Suma Bai K C	Assistant Professor Department of Physics Mar Ivanios College (Autonomous) 7012483831 suma.bai@mic.ac.in	
	Dr. Mathew C T	Assistant Professor Department of Physics Mar Ivanios College (Autonomous) 9847220070 mathew.ct@mic.ac.in	

	Dr. Benzon K B	Assistant Professor Department of Physics Mar Ivanios College (Autonomous) 9946828707 benzon.kb@mic.ac.in	
	Dr. Rajesh S	Assistant Professor Department of Physics Mar Ivanios College (Autonomous) 9495225525 rajesh.s@mic.ac.in	

Category No.	Name	Designation/Office with Phone no. and e-mail id	Category and Guidelines
c)	Dr. Anil Abraham Samuel	Scientist/Engineer-SG **Vikram Sarabhai Space Centre (VSSC)** Thiruvananthapuram 9447708063 anilabraham@vssc.gov.in	Two external experts in the Subject from outside the college, nominated by the Academic Council.
	Dr. R S Jayasree	Scientist F Sree Chitra Tirunal Institute for Medical Science andTechnology Thiruvananthapuram-12 9495948221 jayasree@sctimst.ac.in	
d)	Dr. Jinesh K. B.	Associate Professor, Indian Institute of Space Science & Technology ISRO,Valiyamala Thiruvananthapuram 9961510301 kbjinesh@iist.ac.in	University of Kerala Representative nominated by the Vice-Chancellor ***(The present University nominee will continue till 16.11.2021)***
e)	Mr. Nabeel Koya A	Scientist E , CSG Group, Centre for Development of Advanced Computing (C-DAC) Ministry of Electronics and Information Technology Thiruvananthapuram 9544021134	One representative from industry.

		9895121134 nabeel@cdac.in	
f)	Dr. V. P. Sudeep Kumar	Senior Sub-divisional Engineer BSNL Regional Telecommunication Training Centre, Thiruvananthapuram 9446445455 drvpskumar@gmail.com	One representative from Corporate sector
g)	Dr. G. Subodh	Assistant Professor Department of Physics, University of Kerala, Thiruvananthapuram 9633983404 gsubodh@gmail.com	One representative from allied areas relating to replacement.

Category No.	Name	Designation/Office with Phone no. and e-mail id	Category and Guidelines
h)	Dr. K. J. Thomas	Professor Department of Physics School of Physical Science Central University of Kerala, Kasargode 8943997832 kj_thomas@cukerala.ac.in	One meritorious alumnus who has completed a PG programme of the University nominated by Principal.
i)	Dr. George Varghese,	Emeritus Scientist KSCSTE, Former Professor Calicut University & Visiting Professor Department of Physics Mar Ivanios College (Autonomous) 7907311239 gvphysics@gmail.com (Special Invitee as Academic Consultant)	The Chairman may co-opt, with the Principal's approval, from time to time as special invitees to meetings of BoS, for academic consultation from: (i) Experts from outside the college whenever special courses of studies are to be designed. (ii) Other teachers of the college who are experts in the related discipline.
	Mr. Twinkle A R	Assistant Professor Department of Physics Mar Ivanios College(Autonomous)	

		9605741938 twinkle.ar@mic.ac.in (Expert teacher of related discipline from the Department)	
	Dr. Leenaraj D R	Assistant Professor Department of Physics Mar Ivanios College (Autonomous) 9446316788 leena.raj@mic.ac.in (Expert teacher of related discipline from the department)	
	Dr. Jiji S G	Assistant Professor Department of Physics Ma rIvanios College (Autonomous) 9497851685 jiji.sg@mic.ac.in (Expert teacher of related discipline from the department)	

Principal

Mar Ivanios College

Acknowledgement

The Board of Studies of Physics, Mar Ivanios College (Autonomous), Thiruvananthapuram, places on record their appreciation and gratitude to all the renowned academicians who contributed to the framing of MSc Physics syllabus 2021. The supervision and commendations from the domain specialists in designing the modules of each courses played a decisive role in shaping this curriculum to this present level. I am much indebted to all the members of the present and past Board of Studies whose rational and supportive approach made this venture a grand success.

Dr. Jijimon K Thomas
Chairman, Board of Studies

Thiruvananthapuram
Date: 05 March 2021

Preface

The MSc Physics syllabus reflects the rational points stated in the standards of quality and the course of study approved by the various statutory academic bodies of the college namely the Governing Council, the Academic Council and Board of Studies. The course objectives are the minimum prospects of the completed course. They are organized statements which will be used to measure student achievement. Each objective statement includes the number of the course goal(s) to which the objective relates. The objectives reflect a variety of thinking levels which are designed to provide challenging instruction of all students.

The present syllabus envisages the dissemination of fundamental concepts of physics under various courses of study and thereby equipping the post graduate students with the definite course outcomes expected for each course. Teachers will use this syllabus in training the students for their Post graduate programme in Physics and other national tests. On successful completion of the programme, we expect that the students shall be capable of pursuing doctoral level programmes of any national or international reputed Universities.

Department of Physics has taken systematic efforts to ensure a proportionate curriculum. The faculty members of the Department of Physics had several sitting and deliberations during the design of the curriculum. They had constant interactions with experts in the Board of Studies and other subject experts outside the institution while preparing the syllabus. Many in-house workshops and presentations were organized for the completion of the syllabus.

The MSc Physics programme is aimed at developing specialized skills for students to take up substantial role in scientific, industrial or academic scenario, while giving the practice of independent and group work culture. This curriculum enable students to develop insights into the various specialized research areas including condensed matter physics, semiconductor physics, high energy and particle physics, astrophysics, etc. along with the state of the art laboratory training with a range of experiments from classical to advanced physics.

We have introduced some of the current developments in Physics particularly in the field of high energy particle physics and advanced quantum mechanics .

Description of various nanodevices, spintronics, various electronic instrumentation techniques and importance of group theory for physicists are some of the newly added modules.

This syllabus was developed by the Board of Studies using a teacher task force. Syllabi are in continuous revision. All stakeholders including the faculty members should recommend additions and changes as input to the Board of Studies for further improvements.

REGULATIONS FOR POST GRADUATE PROGRAMMES 2021

Preamble

The Mar Ivanios College (Autonomous), Thiruvananthapuram has been conferred with Autonomy status by the University of Kerala upon recommendations from UGC vide on 13th June 2014. Mar Ivanios College bagged 48th position in the National Institutional Ranking Framework (NIRF) 2020 among the category of Arts, Science and Commerce colleges.

The Department of Physics is one of the oldest departments of the College. The Department started functioning in 1949 when the College was established. The BSc Degree Programme was started in 1957 with a sanctioned strength of 48. In 1995, the MSc degree programme was started with a sanctioned strength of 10. Later in 2000, the Department was upgraded as a Research Centre of the University of Kerala. Currently the Department has ten faculty members and three technical staff. Nine out of the ten faculty members are PhD holders.

In 2008, the Department of Physics received 'DST-FIST support of Rs.50 lakhs. In 2009, the Indian Space Research Organization (ISRO) selected Mar Ivanios College for conducting laboratory course in Physics and Chemistry for Indian Institute of Space Science and Technology (IIST). The Department also received DST-FIST support in 2010 and 2017. From 2007 to 2011 the Department extended its experimental lab facilities for the BTech Aerospace, Avionics and Physical Science students of Indian Institute of Space Science & Technology (IIST) of ISRO.

A total of 105 students have so far registered for PhD at the Centre, of whom 65 have been awarded PhD degree since 2001. Currently there are 30 students carrying out their research here. Faculty members have published more than 400 research papers in international journals and 250 in conference proceedings. They have also participated in 475 conferences including many international symposia. The Department received a total research fund of 300 lakhs over the years from 22 major research projects sanctioned by various agencies like DST, UGC, CSIR, BRNS, DRDO, ISRO, KSCSTE, KSHEC etc. A substantial number of major research instruments were installed in the research division for the smooth conduct of research activities. The Department also has to its credit 10 new entries made in the JCPDS files for new compounds and 8 international patents registered. Two new patent applications have also been submitted. A central instrumentation unit established under UGC-CPE scheme is functioning in the Department.

Regulations

Mar Ivanios College (Autonomous) follows this new syllabus for the Post Graduate programme from the academic year 2021-22 onwards. The Post Graduate programmes of the college are being restructured and revised in tune with the modifications effected at the UGC Curriculum Framework. This will be reflected in the scheme, course content and mode of examination and evaluation system. The revisions were effected based on the recommendations made at the statutory councils of the Autonomous College.

1. Title

1.1. These regulations shall be called **"MAR IVANIOS COLLEGE (AUTONOMOUS) REGULATIONS FOR POST GRADUATE PROGRAMMES 2021"**

2. Scope

2.1 Applicable to MSc Physics programme conducted by the Mar Ivanios College (Autonomous) with effect from 2021 admissions.

2.2 Medium of instruction is English unless otherwise stated there in.

3. Definitions

3.1. **Academic Week** is a unit of five working days in which the distribution of work is organized from day 1 to day 5, with five contact hours of one hour duration on each day.

3.2. **Semester** means a term consisting of **90** working days, within **18** five-day academic weeks for teaching, learning and evaluation.

3.3. **Programme** means two years duration of study and examinations, spread over four semesters, with a set of courses, the successful completion of which would lead to the award of a degree.

3.4. **Course** comprises a set of classes or a plan of study on a particular subject which will be taught and evaluated within a semester of the study programme.

3.5. **Core course** means a course which should compulsorily be studied by a student as requirement in the subject of specialization within a degree programme.

3.6. **Elective Course** means an elective course chosen from the discipline/subject, in an advanced area.

3.7. **Department** means any teaching department in the college.

3.8. **Dean of Studies** is a teacher nominated by the Academic Council to coordinate the academic affairs of the college relating to academic planning, curriculum implementation and review.

3.9. **Department Committee** means the body of all teachers of a department in the college.

3.10. **Faculty Advisor** means a teacher from the parent department nominated by the Department committee, who will advise the students of a class on academic matters.

3.11. **Course Coordinator** means a teacher who is in charge of a course. If a course is taught by more than one teacher, one teacher should be assigned as course coordinator, nominated by the HOD. The course coordinator shall coordinate the internal examination, valuation of answer scripts and other continuous assessments of that particular course.

3.12. **Continuous Internal Assessment (CIA)** means assessment consisting of Attendance, Assignment/Seminar/Viva voce and Examination (theory and practical).

3.13. **End Semester Assessment (ESA)** means examination conducted at the end of each semester for all courses (theory and practical).

3.14. **Internal Examiner** means a teacher working in the college.

3.15. **External Examiner** means a teacher from outside the college.

3.16. **Grace Marks** shall be awarded to candidates as per the orders issued by the University of Kerala

3.17. **Grade** means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Course/Semester/Programme.

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

3.19. Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Act and Statutes of the University, UGC Regulations and the Constitution of the Mar Ivanios College(Autonomous).

4. Eligibility for admission and reservation of seats

Eligibility for admission, norms for admission and reservation of seats for the Postgraduate Programme shall be according to the regulations framed/orders issued by Government of Kerala, University of Kerala and Mar Ivanios College(Autonomous), Thiruvananthapuram in this regard.

5. Programme structure

5.1 The nomenclature of all PG programmes shall be as per the specifications of University Grants Commission and the University of Kerala.

5.2 All the PG Programmes will be of two-year duration with four Semesters. A student may be permitted to complete the Programme, on valid reasons, within a period as prescribed by the University.

5.3 There will be four courses in each semester and one viva voce and dissertation at the end of the fourth semester.

5.4 The Syllabus for all courses in each semester has been divided into three/four/ five modules based on certain thematic commonalities.

6. Scheme of Evaluation

i. The scheme of evaluation for all course shall contain two parts:
   a. Continuous Internal Assessment (CIA)
   b. End Semester Assessment (ESA)

ii. The marks secured for each course shall be converted as grades. The grades for different semesters and overall programme are assigned based on the corresponding semester grade point average and cumulative grade point average respectively.

iii. The mandatory requirement of separate minimum pass percentage for both CIA and ESA is as per the regulations of University/Mar Ivanios College (Autonomous)

6.1 Evaluation of theory courses

The marks allotted for theory courses in End Semester Assessment shall be 75 and that for the Continuous Internal Assessment will be 25.

A. Continuous Internal Assessment (CIA)

The Continuous InternalAssessment for theory is based on the marks obtained for Attendance, Assignment, Seminar and two Test Papers for a particular course.

(i) Attendance

Attendance in all theory and practical classes is compulsory. Students have to secure a minimum percentage of attendance as prescribed by the University/Mar Ivanios College (Autonomous) regulations for each course within a semester to become eligible to register for each End Semester Examination. The attendance percentage will be calculated from the day of commencement of the semester to the last working day of that semester as specified in the semester schedule. Periodic evaluation of each student's attendance shall be done by the respective Class Teacher within each semester [i.e., at least twice within each semester].

Attendance	
Less than 75 %	0 mark
75 %	1 mark
76 to 80 %	2 marks
81 to 85 %	3 marks
86 to 90 %	4 marks
Above 90 %	5 marks

Maximum marks = 5

(ii) Assignment (One assignment per course)

Each student shall be required to do one assignment for each course in each semester. The faculty advisor shall explain to the students the expected quality of an assignment in terms of its structure, content, presentation etc. Valued assignments must be returned to the students.

Evaluation Component	Mark
Review of related literature	1
Content	2
Reference	1
Punctuality	1

Maximum marks = 5

(iii) Seminar

Each student shall present a seminar in each course in each semester on a topic/area allotted. Seminar presentations shall be done in the respective classroom itself so as to benefit all the students. The interaction of the entire class is expected during the seminar presentations. Seminars shall be evaluated on the basis of the quality of the presentation, content, interaction, etc. The course teachers of that semester shall evaluate the seminar and give marks for their course or the average mark of all the evaluators shall be taken as the seminar mark for each course of a semester. All the records of the continuous assessment must be kept in the department and be made available for verification by the concerned authorities, if necessary.

Evaluation Component	Mark
Involvement/punctuality	1
Review of related literature	1
Content & presentation	2
Interactions/ justification and conclusion	1

Maximum marks = 5

(iv) Test paper

For each paper there shall be two internal tests during a semester. The tentative dates of the internal tests shall be announced at the beginning of each semester. Both sets of internal examinations will be conducted by the respective departments as model examinations for three hours and will be based on the question paper pattern for the End

Semester Examination. Marks for the internal tests shall be awarded on the basis of the marks scored for the better of the two tests for each paper. It is mandatory that all students must appear for both tests. There will be no provision for retest. However, retest shall be conducted for genuine reasons subjected to the recommendations of the department committee. The scheme and question paper pattern for the test papers as well as for the End Semester Examination will be prepared by the respective Board of Studies. Valued answer scripts will be made available to the students for perusal 10 working days from the date of the tests.

B. End Semester Assessment (ESE)

End Semester Examinations for each course are conducted at the end of every semester with a maximum mark of 75. Questions shall be set to evaluate the attainment of course outcomes. The question paper for each course will be generated from the Question Bank which is prepared by due mapping of Course Outcomes and Program Specific Outcomes.

6.2 End Semester Examination

A written examination with a maximum marks of 75 and of three hours duration will be conducted.

Pattern of questions

A question paper shall be a judicious mix of short answer type, short essay/problem solving type and long essay type questions.

Theory Papers

Each question paper has three parts: Part A, Part B and Part C

QUESTION PAPER PATTERN
MSc Degree Examination
Branch II PHYSICS
APPYxyz………………………… ……………..
Duration: 3 hours **Maximum marks: 75**
Instructions to question paper setter
1. Each question paper has three parts - Part A, Part B and d Part C
2. Part A contains **eight** short answer questions spanning the entire syllabus, of which the candidate has to answer any ***five***. Each question carries ***three*** marks.
3. Part B contains **six** questions out of which the candidate has to answer any ***four***. Questions shall be selected uniformly from the whole syllabus for that particular course. Each question carries ***ten*** marks
4. Part C contains **seven** problems spanning the entire syllabus. The candidate has to answer any ***four***. Each question carries ***five*** marks
PART A
(Answer any five questions. Each question carries three marks)
I (a)………………………………………………………………………………...
(b)…………………………………………………………………………….
(c)………………………………………………………………………………
(d)…………………………………………………………………………….
(e)…………………………………………………………………………….
(f)………………………………………………………………………………
(g)……………………………………………………………………………
(h)…………………………………………………………………………….
(5 x 3 = 15 marks)
PART B
(Answer any four questions. Each question carries ten marks)
II (a)………………………………………………………………………………
(b)…………………………………………………………………………….
(c)…………………………………………………………………………….
(d)…………………………………………………………………………….
(e)…………………………………………………………………………….
(f)…………………………………………………………………………
(4 x 10 = 40 marks)
Part C
(Answer any four questions. Each question carries five marks)
III (a)…………………………………………………………………………
(b)…………………………………………………………………………
(c)……………………………………………………………………………..
(d)…………………………………………………………………………….
(e)……………………………………………………………………………....
(f)…………………………………………………………………………
(g) …………………………………………………………………………
(4 x 5= 20 marks)

6.3 Evaluation of practical courses

Practical examination will be conducted at the end of an academic year. The time of conduct of the practical examination will be decided by the Department/BoS. Rough records may be properly maintained for each practical paper and should be produced during the End Semester Practical Examinations along with the Fair Record. Each student is encouraged to include critical comments on each experiment done in the original records including sources and estimates of errors, limitations in the experiments done and scope for improvements/additions in the experimental work. In performing Electronics Practical, bread board practice is recommended in addition to soldering of electronic circuits. However, for examination only soldering procedure will be assessed and evaluated.

A. Continuous Internal Assessment

Evaluation Component	Mark
Attendance	5
Lab Involvement and Test	10
Record and Viva	10
Maximum Marks	**25**

The components and the marks can be modified by the concerned BoS/Expert committee within the limit of maximum marks.

B. End Semester Assessment

a. General Physics

Evaluation Component	Marks
Records	10
Brief theory and formula	15
Lay out and performance	15
Observation and tabulation	15
Calculation and graph	10
Viva-voce conducted during the experiment	5
Result and discussion	3
Error analysis	2
Total	**75**

b. Electronics

Evaluation Component	Marks
Records	10
Circuit diagram and designing	10
Skill (performance in layout, soldering and	15

wiring)	
Viva-voce conducted during the experiment	5
Tabulation, graph and error analysis	10
Result and discussion	5
Total	**55**

c. Computer Science

Evaluation Component	Marks
Writing the program	15
Viva-voce during the experiment	3
Result and discussion	2
Total	**20**

The components and the marks can be modified by the concerned BoS/Expert committee within the limit of maximum marks.

6.4 Evaluation of Project

An academic project work shall be done and a dissertation shall be submitted in the final semester of the programme. There will be both CIA and ESA for the project work. The project may be started during the second semester of the MSc programme. 25 marks allotted for the project work is to be awarded on the basis of internal assessment carried out in the College for each student concerned. A rough record for the project work may be maintained by each student in order to help the examiners for evaluating the progress of the project. Each student is required to present the completed project along with experimental demonstration, if any, in the college before the final examinations of the fourth Semester. For the End Semester Assessment of the Project: 50 marks is allotted for Project report and 25 marks is allotted for Project based Viva Voce to be conducted along with General Viva Voce examination.

a. Internal Assessment

Evaluation Component	Mark
Relevance of the topic	5
Project content and report, publication, if any	5
Presentation	10
Project viva	5
Total	**25**

The components and the marks can be modified by the concerned BOS/Expert committee within the limit of maximum marks.

b. End Semester Assessment

The dissertation at the end of final Semester will be evaluated by a panel of one internal evaluator assigned by HOD and one external evaluator/a panel of two external evaluators, as may be decided by the respective BOS. The components and the marks can be modified by the concerned BoS/Expert committee within the limit of maximum marks.

Guidelines for valuation of Project/Dissertation and conducting General Viva-Voce (theory paper based) and Project based Viva-Voce examination

Project Dissertation Evaluation

While evaluating the project dissertation submitted by the candidates the examiner shall check the **o**riginality/novelty of the work, involvement of the candidate in the work, the literature survey done in the area of study, the methodology adopted, the observation/experimental data presented, the theoretical understanding/results and analysis done on the work, discussions made, the scope of the work presented etc.

Viva-Voce examination

The total duration of the Viva-Voce examination is 30-45 minutes per student (depending on the number of candidates allowed)

It consists of two parts-:

Part A : Viva-Voce based on theory papers

Part B : Viva-Voce based on project work

A. General Viva-Voce (Viva-Voce based on Theory papers) Max. Marks: 100

1. Marks shall be distributed as detailed below to ensure uniformity in evaluation
   - (i) A seminar topic (of candidate's choices-MSc level) Presentation : 30 marks
   - (ii) Basic Physics (upto BSc level) : 20 marks
   - (iii) Viva-Voce based on MSc level topics : 50 marks
2. This Viva-Voce examination is mainly to assess the knowledge of students on theoretical principles and concepts, developments and applications in the field of physics
3. The entire topic covered in all the courses in all four semesters shall form the basis for the Viva-Voce examination and it may be ensured that the candidate is at complete ease so that he or she would answer the best of his/her ability.
4. Effort must be taken to reveal what the student knows, enabling the students to answer the questions, rather than to expose what the candidate does not know or unable to communicate under stress/pressure.

Presentation of the Seminar topic can be done either orally or by power point presentation if facilities are available.

(A minimum of 40 % marks and a maximum of 92 % marks may be awarded. Marks above 92 % may be given only to outstanding performance)

B. Viva-Voce based on Project work Max. Marks: 25

(A minimum of 17 marks and a maximum of 23 marks may be awarded. Marks above 23 may be given only for candidates with outstanding performance.)

This is to ascertain

(i) The contribution of the student

(ii) The student's familiarity with the methodology employed

(iii) Whether the student has sufficient theoretical background in the area of study

(iv) Whether the student knows the importance of the work and the results and the conclusions

The marks for Theory papers based Viva-Voce and Project based Viva-Voce examinations should be entered separately. The scheme of valuation should be strictly followed to ensure uniformity of evaluation. All examiners should handover the mark sheets along with the answer books to the Chairman immediately after the completion of the work.

General Viva Voce and project viva-voce	**Project based Viva-voce**	**Comprehensive Viva-voce**
Max Marks	**25**	**100**

No.	**Course Code**	**Course name**	**Project Internal Assessment**	**ESE**	**TOTAL**
1	APPY424	Project	25	75 (Project report and viva voce)	100
2	APPY425	General Viva Voce		100	100

Project Report/ Dissertation	**Statement of Problem and innovation**	**Review of Literature**	**Method -ology**	**Analysis and interpretation of data**	**Language and style**	**Findings and conclusion**	**Total**
Max Marks	8	3	10	20	2	7	**50**

6.5 Evaluation of comprehensive viva voce

A comprehensive viva voce shall be done at the end of the final semester. There will be both In-semester and End-semester assessment for the viva voce examination.

7. Grievance Redressal Mechanism

In order to address the grievance of students regarding internal assessment, a two-level Grievance Redressal Mechanism is established.

Level 1: Department Level: The Department cell is chaired by the HOD, Department Coordinator as member secretary and Course teacher in-charge as member. If the grievance is not redressed at the Department level, the student shall report the grievance to the College Level Grievance Redressal Cell.

Level 2: **College level**: College Level Grievance Redressal Cell has the Vice- Principal as the Chairman, Dean of Student Affairs as the Member Secretary and HOD of concerned Department as member.

8. Eligibility for End Semester Examination

A minimum percentage attendance as prescribed in the University/Mar Ivanios College (Autonomous) regulations for all the courses is mandatory to register for the examination. Condonation of shortage of attendance shall be awarded as per University/Mar Ivanios College (Autonomous) regulations.

9. Promotion to the next Semester

Those students who possess the required minimum attendance and have registered for the End Semester Examination during an academic semester are promoted to the next semester.

10. Eligibility for re-admissions

Eligibility for re-admission shall be according to the provisions given in the University/Mar Ivanios College (Autonomous) regulations

CURRICULUM

PROGRAMME OUTCOMES (PO) –POST GRADUATE PROGRAMME

At the completion of the Post Graduate Programme, the student will be able to accomplish the following programme outcomes.

PO No.	Programme Outcomes
PO.1	**Critical thinking capacity**: Ability to involve in independent and reflective thinking in order to understand logic connections between ideas and mathematical formalism of theoretical and applied physics
PO.2	**Operational communication skill:** Expansion of communication skills for effectively transmitting and receiving information that emphases on acquiring knowledge, problem solving skill, improving curiosity particularly in the physical concepts and related mathematical methods for superior employability
PO.3	**Societal and national perception:** Attain consciousness towards societal issues, human values and professional and disseminating scientific knowledge wherever required and also to keep scientific temper in the society to contribute towards human scientific development
PO.4	**Multidisciplinary approach:** Integrating various disciplines and specialized areas to cross border and redefine problems in order to solve interdisciplinary problems that require simultaneous implementation of concepts from different branches of physics and other related areas
PO.5	**Depth of knowledge:** Acquiring information at a higher level to develop skill and job potential leading to the development of the nation on global standards
PO.6	**Sustained learning practice:** Understanding the requirement of being a continued learner for self-enrichment, professional development and operative partaking in social life in the modern world.

PROGRAMME SPECIFIC OUTCOMES

Upon completion of M.Sc Physics Programmes, the graduates will be able to attain the following programme specific outcomes.

PSO No.	Programme Specific Outcomes (PSO)	PO No:
PSO-1	Obtain advanced knowledge in electrodynamics, classical mechanics, quantum mechanics, statistical mechanics and applied electronics, high energy and nuclear physics, solid state and semiconductor physics and apply it to complex problems in physics and related areas	1,5
PSO-2	Develop expertise in investigating complex problems in physics and in solving them using mathematical and computational techniques	1,2,5
PSO-3	Apply theoretical knowledge and critical cognitive skills	1,2,5
PSO-4	Recognize and apply multi-disciplinary approach	4,5,6
PSO-5	Explore the multidisciplinary areas by studying advanced courses	1.4
PSO-6	Enable the students to take up research activities in both theoretical and physical science	3,5,6

PROGRAMME STRUCTURE

Semester	Paper Code	Paper Name	Teaching Hours	Contact Hours Per Week			Internal (CIA)	ESE	Total
				L	T	P			
Semester I	APPY121	Mathematical Physics - I	72	4	1	-	25	75	100
Semester I	APPY122	Classical Mechanics	90	5	1	-	25	75	100
Semester I	APPY123	Electrodynamics and Modern Optics	90	5	1	-	25	75	100
Semester I	APPY124	Basic Electronics and Electronic Instrumentation	90	5	1	-	25	75	100
Semester I	APPY2P1	General Physics Practical	36	-	-	3	-	-	-
Semester I	APPY2P2	Electronics &Computational Physics Practical	72	-	-	4	-	-	-
		Total for Semester I (S1)		**19**	**4**	**7**			**400**
Semester	**Paper Code**	**Paper Name**	**Teaching Hours**	**Contact Hours Per Week**			**Internal (CIA)**	**ESE**	**Total**
				L	T	P			
Semester II	APPY221	Mathematical Physics - II	72	4	1	-	25	75	100
Semester II	APPY222	Quantum Mechanics - I	90	5	1	-	25	75	100
Semester II	APPY223	Numerical Techniques and Computational Physics	90	5	1	-	25	75	100
Semester II	APPY224	Relativity and Astrophysics	90	5	1	-	25	75	100
Semester II	APPY2P1	General Physics Practical	36	-	-	3	25	75	100
Semester II	APPY2P2	Electronics and Computational Physics Practical	72	-	-	4	25	75	100
		Total for Semester II (S2)		**19**	**4**	**7**			**600**
Semester	**Paper Code**	**Paper Name**	**Teaching Hours**	**Contact Hours Per Week**			**Internal (CIA)**	**ESE**	**Total**
				L	T	P			
Semester III	APPY321	Quantum Mechanics - II	72	4	1	-	25	75	100
Semester III	APPY322	Atomic and Molecular Physics	90	5	1	-	25	75	100
Semester III	APPY323	Statistical Mechanics and Thermodynamics	90	5	1	-	25	75	100

Semester III	APPY324.1 APPY324.2	**Elective Paper - I** Advanced Electronics - I Theoretical physics - I	90	5	1	-	25	75	100
Semester III	APPY4P1	Advanced Physics Practical	36	-	-	3	-	-	-
Semester III	APPY4P2	Advanced Electronics Practical	72	-	-	4	-	-	-
		Total for Semester III (S3)		**19**	**4**	**7**			**400**
Semester	**Paper Code**	**Paper Name**	**Teaching Hours**	**Contact Hours Per Week**			**Internal (CIA)**	**ESE**	**Total**
				L	T	P			
Semester IV	APPY421	Nuclear and High Energy Physics	90	5	1	-	25	75	100
Semester IV	APPY422	Condensed Matter Physics	90	5	1	-	25	75	100
Semester IV	APPY423	Semiconductor Physics and Nanoelectronics	72	4	1	-	25	75	100
Semester IV	APPY424.1 APPY424.2	**Elective Paper - II** Advanced Electronics - II Theoretical Physics - II	90	5	1	-	25	75	100
Semester IV	APPY4P1	Advanced Physics Practical	36	-	-	3	25	75	100
Semester IV	APPY4P2	Advanced Electronics Practical	72	-	-	4	25	75	100
Semester IV	APPY425	Project	-	-	-	-	25	75	100
Semester IV	APPY426	Viva Voce	-	-	-	-	-	100	100
		Total for Semester IV(S4)		**19**	**4**	**7**			**800**
		Grand Total					**525**	**1675**	**2200**

Course Details	
Code	**APPY121**
Title	**Mathematical Physics - I**
Degree	M.Sc.
Branch	Physics
Year/Semester	1/I
Hours/week	4
Total hours	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Identify different types of matrices and apply them in physical problems	U, Ap	1,2,3
2	Understand the orthogonal curvilinear coordinates and identify the different differential operators, namely, gradient, divergence, curl and Laplacian	U,R	1
3	Apply Gamma, Beta and Delta functions in Various derivations and applications	Ap	1,2,3
4	Use Fourier series, Fourier transform and Laplace transform in fields of physics like digital signal processing, spectroscopy, etc.	An, Ap	1,2,3
5	Solve first and second order differential equations, both, homogeneous and non-homogeneous	An	1,2,3
6	Identify the different types of second order differential equations, namely, Bessel, Legendre, Hermite, Laguerre, Chebyshev and hypergeometric and hence write their solutions and apply them in the derivations of many Physical problems	U, Ap	1,2,3

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Vector Spaces and Matrices**		**10**	
1.1	Hilbert space - linear equations - eigen value problem		2	1
1.2	Orthogonal matrices - Hermitian matrices and unitary matrices		2	1
1.3	Diagonalization of matrices		2	1
1.4	Eigenvector and eigen values		1	1
1.5	Singular matrices		1	1
1.6	Inverse of matrix		2	1
2.0	**Curvilinear Coordinates**		**5**	
2.1	Orthogonal curvilinear coordinates		1	2
2.2	Differential operator-gradient ,divergence ,curl and Laplacian in Cartesian, cylindrical and spherical polar coordinates		4	2
3.0	**Gamma (Γ), Beta (β) and Delta (δ) functions**		**6**	
3.1	Gamma function – values of Γ of integers and half integers		2	3
3.2	β function – relation between β and Γ functions		1	3
3.3	Error function		1	3
3.4	Dirac delta function - representation of δ function - properties of δ function		2	3
4.0	**Fourier Series**		**10**	
4.1	Periodic functions - Fourier series - even and odd functions		1	4
4.2	Convergence of Fourier series and Dirichlet's conditions		1	4
4.3	Half range series in the interval 0 to π	**36**	2	4
4.4	Change of interval from $(-\pi,\pi)$ to $(-l, l)$		1	4
4.5	Parseval's identity for Fourier series		1	4
3.6	Gibb's phenomenon		2	4
3.7	Applications of Fourier series		2	4
5.0	**Fourier Transform**		**5**	
5.1	Definition - properties of Fourier transform		3	4
5.2	Discrete Fourier transform		1	4
5.3	Fast Fourier transform		1	4
6.0	**Laplace Transform**		**8**	
6.1	Definition - elementary functions		1	4
6.2	Properties of Laplace transform - derivatives		2	4
6.3	Inverse Laplace transform - properties of inverse Laplace transform		2	4
6.4	Application to solution of simple differential equations		3	4
7.0	**Differential Equations**		**8**	
7.1	Partial differential equations		1	5
7.2	First order differential equations		1	5
7.3	Separation of variables		1	5
7.4	Singular points		2	5
7.5	Series solution and Frobenius method	**36**	1	5
7.6	Non-homogeneous equations - Green's function		2	5

8.0	**Special Functions**		**20**	
8.1	Bessel’s differential equation - Besself unction - generating function - integral representation - recurrence relations - orthogonality - Neumann functions - Hankel functions - modified Bessel functions - spherical Bessel functions		5	6
8.2	Legendre differential equation - Legendre function - Rodrigue’s formula – generating function - recurrence relations - orthogonality - associated Legendre polynomials - orthogonality of associate Legendre polynomial (statement only) - spherical harmonics		5	**6**
8.3	Hermite differential equation - Hermite function - Rodrigue’s formula - recurrence relations - generating function - orthogonality		3	**6**
8.4	Laguerre’s differential equation - Laguerre function - generating function - Rodrigue’s formula - recurrence relations - orthogonality		3	**6**
8.5	Chebyshev polynomials - generating unction - type I and type II - recurrence relations		2	**6**
8.6	Hypergeometric functions		2	**6**

Books for Study

1. G. B. Arfken and H. J. Weber, Mathematical Methods for Physicists, 6^{th} Edition, Elsevier Academic Press (2005)
2. K. F. Riley, M. P. Hobson, S. J. Bence, Mathematical Methods for Physics and Engineering, 3^{rd} Edition, Cambridge University Press (2006)
3. Satya Prakash, Mathematical Physics with Classical Mechanics, 6^{th} Revised Edition, Sultan Chand & Sons, New Delhi (2017)
4. Pipes L. A. and Harvill L. R., Applied Mathematics for Engineers and Physicists, 3^{rd} Edition, McGraw-Hill Book Company (1982)
5. B. S. Rajput, Mathematical Physics, 15^{th} Edition, Pragati Prakashan, Meerut (2001)
6. H.K. Dass and RamaVerma, Mathematical Physics, Revised Edition, S. Chand & Company Pvt. Ltd. (2014)
7. B. D. Gupta, Mathematical Physics, Revised 2^{nd} Edition, Vikas Publishing House Pvt. Ltd. New Delhi (1995)
8. S. Chandra & M. K. Sharma, An Introduction to Mathematical Physics, Narosa Publishing House, New Delhi (2013)
9. V. Balakrishnan,Mathematical Physics with Applications, Problems and Solutions, Ane Books Pvt. Ltd. New Delhi (2018)
10. P. K. Chattopadhyay, Mathematical Physics, New Age International Publishers, New Delhi (2006)

Course Details	
Code	**APPY122**
Title	**Classical Mechanics**
Degree	M.Sc.
Branch	Physics
Year/Semester	1/I
Hours/week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Recollect the basic ideas in analytical mechanics	R	1
2	Formulate the Lagrangian mechanics concepts and solve the problems with the help of Lagrangian equation.	Ap	1,2,3
3	Compare the formulation of Hamiltonian and Lagrangian mechanics and solve the problems of classical mechanics	An	1,2
4	Solve the problems of generating function, canonical transformation & Poisson brackets	Ap	1,2,3
5	Formulate the equations of rigid body dynamics and demonstrate the examples of non-inertial frames of reference.	U	1,3
6	Compare the linear and non-linear dynamical systems	An	1,2
7	Describe chaos, fractals and solitons	U	1,3
8	Demonstrate the ability to apply basic methods of Classical mechanics towards solutions of various problems, including the problems of complicated oscillatory systems and the motion of rigid bodies	U	1,3
9	Describe the differential equations and other advanced mathematics in the solution of the problems of mechanical systems	U	1,2

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze;
E- Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Lagrangian Mechanics**	36	**12**	
1.1	Mechanics of a particle and system of particles - constraints		2	1
1.2	D'Alembert's principle and Lagrange's equations		2	1
1.3	Simple applications of Lagrangian formulation		2	1
1.4	Hamilton's principle - techniques of calculus of variations		2	1,2,3
1.5	Derivation of Lagrange's equations from Hamilton's principle		2	1,2,3
1.6	Conservation theorems and symmetry properties		2	1,2
2.0	**Two Body Central Force Problem**		**14**	
2.1	Reduction to one body problem - equations of motion - equivalent one dimensional problem		3	1,2
2.2	Virial theorem		2	1,2
2.3	Differential equation for the orbit in the case of integrable power law potentials		2	1,2
2.4	Kepler's problem - inverse square law of force		3	1,2
2.5	Scattering in central force field		2	1,2
2.6	Transformation of the scattering problem to laboratory coordinates		2	1,2
3.0	**Theory of Small Oscillations**		**10**	
3.1	Formulation of the problem - eigen value equation		2	1,2
3.2	Eigen vectors and eigen values - orthogonality		2	1,2
3.3	Equilibrium and potential energy		2	1,2,8
3.4	Theory of small oscillations - normal modes with examples		2	1,2,8
3.5	Longitudinal vibrations-longitudinal vibrations of carbon dioxide molecule		2	1,2,8
4.0	**Hamiltonian Mechanics**	36	**12**	
4.1	Generalized momentum and cyclic coordinates - conservation theorems		3	1,3
4.2	Hamilton's equations - examples in Hamiltonian dynamics (harmonic oscillator - motion of a particle in a central force field - charged particle in an electromagnetic field - compound pendulum)		3	1,3
4.3	Canonical transformations - generating functions		2	1,3,4
4.4	Poisson brackets - equation of motion in Poisson bracket form - angular momentum - Poisson brackets		2	1,3,4
4.5	Liouville's theorem		2	1,3
5.0	**Hamilton-Jacobi Equations**		**10**	
5.1	Hamilton-Jacobi equation		2	1,3,4
5.2	Harmonic oscillator as an example		2	1,3,4
5.3	Separation of variables in Hamilton-Jacobi equation		2	1,3,4
5.4	Action angle variables - Kepler's problem		2	1,3,4

5.5	H-J equation and the Schrödinger equation		2	1,3,4
6.0	**Rigid Body Dynamics**		**14**	
6.1	Generalized coordinates of rigid body - Euler's angles		2	1,3,5
6.2	Infinitesimal rotations as vectors - angular velocity, angular momentum and inertia tensor		3	1,3,5
6.3	Principal axes - Principal moments of inertia - Rotational kinetic energy of a rigid body		3	1,3,5
6.4	Euler's equations of motion of a rigid body		2	1,3,5
6.5	Torque free motion of a rigid body - force free motion of symmetrical top		2	1,3,5
6.6	Motion of heavy symmetrical top		2	1,3,5
7.0	**Introduction to Non-linear Dynamics**	**18**	**10**	
7.1	Linear and non-linear systems		2	1,6
7.2	Integration of second order non-linear differential equation		2	1,6
7.3	Pendulum equation		2	1,6
7.4	Phase plane analysis of dynamical systems		2	1,6
7.5	Linear stability analysis - limit cycles		2	1,6
8.0	**Chaos, Fractals and Solitons**		**8**	
8.1	Introduction to chaos - logistic map strange attractors		2	1,7
8.2	Bifurcation - Lyapunov exponent - Routes to chaos		2	1,7
8.3	Elementary ideas of fractal and fractal dimension		2	1,7
8.4	Introduction to solitons - KdVequations and solutions		2	1,7

Books for Study

1. H. Goldstein, C. Pooleabd S. Safko, Classical Mechanics, 3rd Edition, Pearson Education Inc. (2008)
2. J. C. Upadyaya, Classical Mechanics, Revised Edition, Himalaya Publishing Company (2005)
3. G. Aruldhas, Classical Mechanics, Prentice Hall of India Pvt. Ltd. (2008)
4. P. G. Drazin and R. S. Johnson, Solitons – An Introduction, Cambridge University Press (1989)
5. N. C. Rana and P. S. Joag, Classical Mechanics, Tata McGraw Hill (1991)
6. V. B.Bhatia, Classical Mechanics: With Introduction to Nonlinear Oscillations and Chaos, Narosa Publishing House(1997)
7. M. Tabor, Chaos and Integrability in Nonlinear Dynamics: An Introduction, John Wiley & Sons (1989)
8. Tom W. B. Kibble and Frank H. Berkshire, Classical Mechanics, 5th Edition, Imperial College Press (2004)
9. Laxmana, Nonlinear Dynamics, Springer Verlag (2001)
10. Steven H. Strogetz, Nonlinear Dynamics and Chaos, Addison-Wesley Publishing Company (1994)

Course Details	
Code	**APPY123**
Title	**Electrodynamics and Modern Optics**
Degree	M.Sc.
Branch	Physics
Year/Semester	1/I
Hours/week	5
Total Hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Apply wave optics and diffraction theory to arange of problems in interference, diffraction and polarization	Ap	1,2,4
2	Apply the principles of non-linear optics to materials used in optics and photonics	U	1,3
3	Solve problems in classical electrodynamics using special techniques	Ap	1,2,4
4	Formulate and solve electromagnetic problems with the help of electrodynamic potentials and make a detailed account for gauge transformations and their use.	An	1,4
5	Formulate and solve electrodynamic problem in relativistically covariant form in four-dimensional space time	R	1,3,5
6	Calculate the electromagnetic radiation from a localized charge which moves arbitrarily in time and space taking into account the retardation effect	An	1,5
7	Analyze waveguide structures propagating TE, TM or TEM modes	An	1,3,4
8	Solve numerical problems in advanced optics, electrodynamics, radiations and relativistic electrodynamics	Ap	1,2

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Elements of Modern Optics**	**36**	**24**	
1.1	Interference with multiple beams		2	1,8
1.2	Fabry-Perot interferometer		2	1,8
1.3	Resolution of Fabry-Perot Instruments		2	1,8
1.4	Theory of multilayer films		2	1,8
1.5	Diffraction - Kirchhoff's theorem		2	1,8
1.6	Fresnel-Kirchhoff formula		2	1,8
1.7	Fraunhofer diffraction patterns		2	1,8
1.8	Multiple slits - diffraction grating - resolving power of a grating		2	1,8
1.9	Fresnel diffraction patterns		2	1,8
1.10	Applications of Fourier transform to Diffraction		2	1,8
1.11	Holography – reconstruction of wavefronts by diffraction		2	1,8
1.12	Propagation of light in crystals		2	1,8
2.0	**Non-linear Optics**		**12**	
2.1	Physical origin of non-linear polarization		2	2,8
2.2	Electromagnetic wave propagation in non-linear media		2	2,8
2.3	Second harmonic generation		2	2,8
2.4	Ideas of parametric amplification		2	2,8
2.5	Electro-optic modulation of laser beams		2	2,8
2.6	Solitons (elementary ideas)		2	2,8
3.0	**Fundamentals of Plasmons**	**18**	**6**	
3.1	Maxwell's equations and electromagnetic wave propagation		1	8
3.2	Dielectric function of the free electron gas		2	8
3.3	Dispersion of free electron gas and volume plasmons		2	8
3.4	Surface plasmons (elementary ideas)		1	8
4.0	**Special Techniques**		**12**	
4.1	Laplace's Equation - Laplace's equation in one, two and three dimensions		1	3,8
4.2	Boundary conditions and uniqueness theorem		1	3,8
4.3	Conductors and the second uniqueness theorem		1	3,8
4.4	The method of images		2	3,8
4.5	Separation of variables - Cartesian coordinates - spherical coordinates		4	3,8
4.6	Multipole expansion – Approximate potential at large distances		1	3,8
4.7	The monopole and dipole term		1	3,8
4.8	Origin of coordinates in multipole expansion		1	3,8

5.0	**Potentials and Fields**		**12**	
5.1	Magnetic vector potential and scalar potentials		1	4,8
5.2	Gauge transformations		1	4,8
5.3	Coulomb gauge and Lorentz gauge		1	4,8
5.4	Lorentz force law in potential form		1	4,8
5.5	Retarded potential		2	4,6,8
5.6	Electric dipole radiation		1	4,6,8
5.7	Magnetic dipole radiation		1	4,6,8
5.8	Lienard-Wiechert potentials		2	4,6,8

5.9	The field of a moving point charge	36	2	4,7,8
6.0	**Relativistic Electrodynamics**		**6**	
6.1	Motion of a charged particle in a uniform static electric and magnetic field		1	5,8
6.2	Magnetism as a relativistic phenomenon		1	5,8
6.3	Transformation of the field		2	5,8
6.4	Electromagnetic field tensor		2	5,8
7**.0**	**Electromagnetic Waves**		**18**	
7.1	Plane electromagnetic wave through linear media		2	7,8
7.2	Reflection and transmission - normal and oblique incidence		3	7,8
7.3	Absorption and dispersion		2	7,8
7.4	Rectangular waveguides		3	7,8
7.5	Transverse Magnetic (TM) Modes		3	7,8
7.6	Transverse Electric (TE) Modes		3	7,8
7.7	Power transmission - Attenuation factor		2	7,8

Books for Study

1. G. R. Fowels, Introduction to Modern Optics, 2nd Edition, Dover Publications (1989)
2. A. Yariv, Introduction to Optical Electronics, Holt, Rinehart and Winston, New York (1976)
3. Stefan Maier, Plasmonic: Fundamentals and Applications, Springer (2007)
4. David J. Griffiths, Introduction to Electrodynamics, PHI Learning India Pvt. Ltd. (2007)
5. J. D Jackson, Classical Electrodynamics, Wiley Publishers, New York (1975)
6. Mathew N. O. Sadikku, Elements of Electromagnetics, Oxford University Press (2007)
7. L. D. Landau and E. M. Lifshitz,The Classical theory of fields, Pergamom Press Ltd (19971)

Course Details	
Code	**APPY124**
Title	**Basic Electronics and Electronic Instrumentation**
Degree	M.Sc.
Branch	Physics
Year/Semester	1/I
Hours/week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Design of electronic circuits	U, An	2
2	Identify and solve the problems related to electronic circuits	U,Ap	2,3
3	Familiarize the different solid state devices	R,U	1,3
4	Have a thorough understanding of the fundamental concepts and techniques used in digital electronics	U	1,3,4
5	Understand, analyze and design various combinational and sequential circuits	An	3,4
6	Develop the skill to identify trouble shoot digital circuits	U,Ap	1,3
7	Get a comprehensive idea about the theory and behavior of optical fibers, light sources, detectors and optical amplifiers	R,U	1,2
8	Understand the degree of distortion of optical signals as they propagate along the fiber	U,An	2,4
9	Get a thorough knowledge about the analog and digital instrumentation for measurements	R,U,Ap,An,C	1,2,3,4,6
10	Develop skills in error analysis	Ap	3

*PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Electronic Circuits**	**36**	**36**	
1.1	Frequency effects - frequency response of an amplifier circuit - power and voltage gain - impedance matching - Bode plots - Miller effects - rise time bandwidth relations		7	1,2
1.2	Frequency analysis of BJT and FET amplifier stages		3	2,3,4
1.3	Active filters and oscillators - first order and second order butterworth transfer function - first order and second order active filters		5	2,3
1.4	Low pass, high pass and band pass filters		5	3,4,5
1.5	Square, triangular and saw tooth wave form generators		4	2,3
1.6	Wienbridge oscillator - comparators - OP-Amp as a voltage comparator		4	1,2,3,4
1.7	Zero crossing detectors - Schmitt trigger - Voltage regulators - specialized IC applications - monostable and astable multivibrator circuits using IC555 timer - Phase Locked Loop circuits (PLL)		8	1,2,3,4
2.0	**Digital Electronics**	**18**	**18**	
2.1	Arithmetic and data processing digital circuits - binary adder and subtracter - arithmetic logic unit		1	4,5
2.2	Binary multiplication and division - Karnaugh map and simplification		2	5,6
2.3	Multiplexers - demultiplexers - BCD to decimal converters		2	4,6
2.4	Encoders - digital comparators		1	4
2.5	Parity generators and checkers - programmable logic arrays		2	5,6
2.6	Sequential digital circuits - flip flop - clocked SR flip flop - JK flip flop - D flip flop - JK master-slave flip flop		2	5
2.7	Different types of registers – shift registers and applications		2	6
2.8	Asynchronous and synchronous electronic counters		2	4,6
2.9	Decade counters - digital clock		2	5
2.10	Applications of electronic counters		2	5,6
3.0	**Optoelectronics**	**18**	**18**	
3.1	Optical fiber as a waveguide - mode theory of circular waveguides		1.5	2,3,4
3.2	Waveguide equations		2.5	3,4
3.3	Modes in step index fibers		3	2
3.5	Propagation of modes in single mode fibers		1.5	4,5
3.5	Signal degradation in optical fibers - attenuation and signal distortion in optical fibers - sources of attenuation and signal distortion		3	1,2,3,4,5
3.6	Optical sources - LEDs and laser diodes		3	1,2,3
3.7	Photo detectors		1.5	2,3,4
3.8	Optical amplifiers - semiconductor and fiber amplifiers		2	1,2,5
4.0	**Electronic Instrumentation**	**18**	**18**	
4.1	Measurements - comparison between analog and digital instruments - performance and dynamic characteristics		2	1,2,3
4.2	Ideas of errors - types - statistical analysis - probability of errors and Gaussian curve - measurement standards		3.5	4,5

4.3	Instruments - voltmeters - ammeters - ohmmeters - multimeters - balance bridge voltmeters		**3.5**	2,3,4
4.4	Oscilloscopes - Components of a CRO - Cathode Ray Tube (CRT) - Dual beam and Dual trace CRO - Digital storage CRO		**2.5**	1,2,3
4.5	Transducers - active and passive transducers - force and displacement transducers - strain gauges		**3.5**	4,5,6
4.6	Thermistors - thermocouples - flow measurements		**3**	1,3,4,5

Books for Study

1. A. Malvino and D. J. Bates, Electronics Prinicples, 7th Edition, Tata McGraw Hill (2007)
2. R. A. Gayakwad, Operational Amplifiers and Linear Integrated Circuits, Prentice Hall of India (2000)
3. M. S.Tyagi, Introduction to semiconductor materials and devices, Wiley India (2005)
4. B. G. Streetman, S. K. Banerjee, Solid State Electronic Devices. Pearson Education (2010)
5. D. P. Leach, A. P. Malvino and G. Saha, Digital Principles and Applications, Tata McGraw Hill (2011)
6. G. Keiser, Optical Fibre Communication, 3rd Edition,Tata McGraw Hill (2000)
7. Lal Kishore, Electronic measurements and Instrumentation, Dorling Kindersley (India) Pvt. Ltd. (2010)
8. J. Millman, C. Halkias and C. D. Parikh, Integrated Electronics, Tata McGraw Hill (2010)
9. T. F. Bogart, J. S. Beasley and G. Rico, Electronic Devices and Circuits, 6th Edition, Pearson Inc. (2004)
10. Thomas L. Floyd, Digital Fundamentals, 10th Edition, Dorling Kindersley (India) Pvt. Ltd. (2011)
11. Joachim Piprek, Semiconductor Optoelectronic Devices, Academic Press (2003)
12. W. D. Cooper, A. O. Helfrik and H. Albert, Electronic Instrumentation and Measurement Techniques, PHI (1997)
13. Charles K. Kao, Optical Fiber Systems: Technology, Design and Applications, Tata McGraw Hill (1982)

Course Details	
Code	**APPY221**
Title	**Mathematical Physics - II**
Degree	M.Sc.
Branch	Physics
Year/Semester	1/II
Hours/week	4
Total hours	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Analyse analytic functions and identify various complex functions	R, An	1,2,3
2	Apply Taylor series, Laurent series and calculus of residue to various physical problems	Ap, E	1,2,3
3	Analyse and use different types of distributions, like, binomial, Poisson, Gauss-normal, χ^2 and student 't' distributions	U, An	1,2,3
4	Apply tensors in various fields of physics	Ap	1,2,3
5	Apply group theory to the field of crystallography and spectroscopy	Ap	1,2,3

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	**Course Description**	**Hrs**	**Hrs**	**CO No.**
1.0	**Complex Variables**	**36**	**24**	
1.1	Functions of a complex variable		1	1
1.2	Analytic function - necessary and sufficient conditions for a function to be analytic		2	1
1.3	Cauchy-Riemann conditions		1	1
1.4	Cauchy-Riemann equations in polar form		1	1
1.5	Harmonic functions		2	1
1.6	Trigonometric hyperbolic and logarithmic functions		3	1
1.7	Line integrals of complex functions		2	1
1.8	Cauchy's integral theorem - Cauchy's integral formula		2	1
1.9	Derivatives of analytic functions		2	1
1.10	Taylor series		1	2
1.11	Laurent series		1	2
1.12	Singularities of an analytical function		2	2
1.13	Residues - calculus of residues - the residue theorem -evaluation of definite integrals		3	2

1.14	Dispersion relations		1	2
2.0	**Probability**		**12**	
2.1	Definitions and simple properties of probability		1	3
2.2	Random variables		1	3
2.3	Chebychev inequality and moment generating function		1	3
2.4	Binomial distributions		2	3
2.5	Poisson distribution		2	3
2.6	Gauss' normal distribution		2	3
2.7	Error analysis and least square fitting		1	3
2.8	χ2 distribution		1	3
2.9	Student 't' distribution		1	3
3.0	**Tensor Analysis**		**18**	
3.1	Transformation of coordinates in linear space - summation convention		1	4
3.2	Contravariant, covariant and mixed tensors		1	4
3.3	Kronecker delta		1	4
3.4	Algebraic operations in tensors		1	4
3.5	Quotient law		1	4
3.6	Symmetric and anti-symmetric tensors		1	4
3.7	Metric tensor - conjugate metric tensor		3	4
3.8	Associated tensor		1	4
3.9	Tensor calculus - covariant derivative		1	4
3.10	Intrinsic derivative	**36**	1	4
3.11	Christoffel's symbols - Christoffel's symbols in rectangular, cylindrical and spherical polar coordinates		2	4
3.12	Riemann-Christoffel curvature tensor - Ricci tensor		2	4
3.13	Kinematics in Riemannian space		2	4
4.0	**Group Theory**		**18**	
4.1	Definition of a group - abelian group		1	5
4.2	Group of transformations - group of symmetries of an equilateral triangle and a square		1	5
4.3	Multiplication table		1	5
4.4	Conjugate elements and classes		2	5
4.5	Subgroups		1	5
4.6	Direct product of groups		1	5
4.7	Homomorphism and isomorphism		1	5
4.8	Representation theory of groups - representation of finite groups		1	5
4.9	Invariant subspaces and reducible representations		2	5
4.10	Schur's lemmas and the orthogonality theorem (statement only)		1	5
4.11	Characters of representations - example of C4v group		2	5
4.12	Continuous groups - Lie groups		1	5
4.13	Axial rotation group SO(2)		1	5
4.14	Special unitary group SU(2) - irreducible representation of SU(2)		2	5

Books for Study

1. G. B. Arfken & H. J. Weber, Mathematical Methods for Physicists, 6th Edition, Academic Press (2005)
2. K. F. Riley, M. P. Hobson, S. J. Bence, Mathematical Methods for Physics and Engineering, 3rd Edition, Cambridge University Press (2006)
3. Satya Prakash, Mathematical Physics with Classical Mechanics, 6th Revised Edition, Sultan Chand & Sons, New Delhi (2017)
4. H. K. Dass & Rama Verma, Mathematical Physics, Revised Edition, S. Chand & Company Pvt Ltd, New Delhi (2014)
5. B. D. Gupta, Mathematical Physics, Revised 2ndEdition, Vikas Publishing House Pvt. Ltd. New Delhi (1995)
6. M. R. Spiegel, Schaum's Outline of Theory and Problems of Vector Analysis and an Introduction to Tensor Analysis, McGraw hill Book Company, New York (1974)
7. A.W. Joshi, Matrices and Tensors in Physics, 4thEdition, New Age International Publishers New Delhi (2017)
8. A. W. Joshi, Elements of Group Theory for Physicists, Revised 4th Edition, New Age International Publishers, New Delhi (2015)
9. R.V Churchill & Brown J. W, Complex Variables and Applications, 6th Edition, McGraw-Hill Book Co. Inc. (1996)
10. Pipes L.A. & Harvill L.R., Applied Mathematics for Engineers and Physicists, 3rd Edition, McGraw-Hill Book Company (1982)
11. V. Balakrishnan, Mathematical Physics with Applications, Problems and Solutions, Ane Books Pvt Ltd, New Delhi (2018)
12. Tung Wu-Ki, Group Theory in Physics, World Scientific, Singapore (1995)
13. S. Chandra & M. K. Sharma, An Introduction to Mathematical Physics, Narosa Publishing House, New Delhi (2013)
14. P. K. Chattopadhyay, Mathematical Physics, New Age International Publishers, New Delhi (2006)

Course Details	
Code	**APPY222**
Title	**Quantum Mechanics - I**
Degree	M.Sc.
Branch	Physics
Year/Semester	1/II
Hours/week	5
TotalHours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Developaknowledgeaboutfundamentalquantummechanicalprocessesinnature	R	1,2,3,6
2	Acquire a general experience with non-relativistic quantum mechanics that is useful for further studies in theoretical physics, as well as nanotechnology	U	1,2,3,6
3	Solve time-dependent and time-independent Schrödinger equation for simple potentials	U	1,2,3,6
4	Solve problems related to spin, angular momentum states, angular momentum addition rules and identical particles	Ap	1,2,3,6
5	Apply the variational method, time-independent perturbation theory and time-dependent perturbation theory to solve simple problems	Ap	1,2,3,6
6	Experience using mathematical tools to construct approximate quantum mechanical models	Ap	1,2,3,6
7	Solve basic physical problems using quantum mechanical techniques	Ap	1,2,3,6

PSO-Program specific outcome; CO-Course Outcome;
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Foundations of Quantum Mechanics**		**18**	
1.1	Basic postulates of quantum mechanics		2	1,2,7
1.2	Hilbert space		2	1,2,7
1.3	Observables		1	1,2,7
1.4	Hermitian operators - general statistical interpretation		1	1,2,7
1.5	Uncertainty principle		1	1,2,7
1.6	Minimum uncertainty - wave packet - energy time uncertainty principle		1	1,2,7
1.7	Dirac notation		2	1,2,7
1.8	Matrix representation of state vectors and operators		1	1,2,7
1.9	Change of representations		1	1,2,7
1.10	Eigen value problem in matrix mechanics		1	1,2,7
1.11	Energy and momentum representations		1	1,2,7
1.12	Unitary transformations involving time		1	1,2,7
1.13	Schrodinger, Heisenberg and interaction pictures		2	1,2,7
1.14	Basic postulates of quantum mechanics		1	1,2,7
2.0	**Exactly Solvable Problems in Quantum Mechanics**		**18**	
2.1	One dimensional eigen value problems	**36**	1	2,3,7
2.2	Square well potential		1	2,3,7
2.3	Potential barrier		1	2,3,7
2.4	Alpha particle emission		1	2,3,7
2.5	Bloch waves in periodic potential		1	2,3,7
2.6	Kronig-Penny square well potential		2	2,3,7
2.7	Linear harmonic oscillator problem using wave mechanics and operator methods		2	2,3,7
2.8	Free particle wave functions and solutions		1	2,3,7
2.9	Three dimensional eigen value problems		1	2,3,7
2.10	Particle moving in spherical symmetric potential		2	2,3,7
2.11	Rigid rotator		1	2,3,7
2.12	Hydrogen atom problem		2	2,3,7
2.13	Three dimensional potential well		1	2,3,7
2.14	Deuteron		1	2,3,7
3.0	**Heisenberg Method**		**9**	
3.1	The Heisenberg method		1	2,3,7
3.2	Matrix representation of wave function		2	2,3,7
3.3	Matrix representation of operator		1	2,3,7
3.4	Properties matrix elements		1	2,3,7
3.5	Schrodinger equation in matrix form		1	2,3,7
3.6	Eigen value problems		1	2,3,7

3.7	Unitary transformations	18	1	2,3,7
3.8	Linear harmonic oscillator		1	2,3,7
4.0	**Symmetry and Conservation Laws**		**9**	
4.1	Symmetry transformations		2	2,4,7
4.2	Space translation and conservation of angular momentum		2	2,4,7
4.3	Time translation and conservation of energy		2	2,4,7
4.4	Rotation in space and conservation of angular momentum		1	2,4,7
4.5	Space inversion		1	2,4,7
4.6	Time reversal		1	2,4,7
5.0	**Angular Momentum**	36	**9**	
5.1	Angular momentum in operators and commutation relations		2	2,4,7
5.2	Eigen values and eigen functions of L^2 and L_z - general angular momentum		2	2,4,7
5.3	Eigen values of J^2 and J_z		1	2,4,7
5.4	Angular momentum matrices - spin angular momentum - spin vectors for a spin ½ system		2	2,4,7
5.5	Addition of angular momentum		1	2,4,7
5.6	Clebsch-Gordan coefficients		1	2,4,7
6.0	**Time Independent Perturbation Theory**		**11**	
6.1	Time independent perturbation - basic concepts		2	5,6,7
6.2	Non-degenerate energy levels		2	5,6,7
6.3	Anharmonic oscillator ground state of helium		2	5,6,7
6.4	Effect of electric field on the ground state of hydrogen		2	5,6,7
6.5	Degenerate energy levels		1	5,6,7
6.6	Effect of electric field on the n=2 state of hydrogen		1	5,6,7
6.7	Spin-orbit interaction		1	5,6,7
7.0	**Variation Method**		**7**	
7.1	The variational principle		2	6,7
7.2	Rayleigh Ritz method		2	6,7
7.3	Variation method for excited states		1	6,7
7.4	The Hellmann-Feynman theorem		1	6,7
7.5	Ground state of helium and deuteron		1	6,7
8.0	**WKB Approximation**		**9**	
8.1	WKB method		2	6,7
8.2	Connection formulas		2	6,7
8.3	Validity of WKB method		1	6,7
8.4	Barrier potential		1	6,7
8.5	Penetration		1	6,7
8.6	Alpha particle emission		1	6,7
8.7	Bound states in a potential well		1	6,7

Books for Study

1. G. Aruldhas, Quantum Mechanics, 3rd Edition, PHI learning Pvt. Ltd. (2009)
2. P. M. Mathews and K.Venkitesan, A Text Book of Quantum Mechanics, 2nd Edition, Tata McGraw Hill (2010)
3. D. J. Griffiths, Introduction to Quantum Mechanics, 2nd Edition, Pearson Education Inc. (2005)
4. V. K. Thankappan, Quantum Mechanics, 2ndEdition, New Age International Pvt. Ltd. (2003)
5. A. Ghatak and S. Lokanathan, Quantum Mechanics Theory and Applications, KluewerAcademic Publishers (2004).
6. S. Devanarayanan, Quantum Mechanics, Scitech Publications (India) Pvt. Ltd. (2005)
7. J. J. Sakurai, Advanced Quantum Mechanics, Pearson Education Inc. (2009)
8. Richard Liboff, Introductory Quantum Mechanics, 4th Edition, Pearson Education Inc. (2009)

Course Details	
Code	**APPY223**
Title	**Numerical Techniques and Computational Physics**
Degree	M.Sc.
Branch	Physics
Year/Semester	1/II
Hrs/Week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems	U	1,4,5
2	Apply numerical methods to obtain approximate solutions to mathematical problems.	Ap	2,4,5
3	Analyze and evaluate the accuracy of common numerical methods	An,E	1,4,5
4	Demonstrate computer architecture concepts related to design of modern processors, memories and I/Os	R	5,6
5	Develop logic for programming language	U	1,4
6	Develop the ability to synthesize the acquired knowledge, understanding and experience for a better and improved comprehension of the real-life problems	Ap	1,3
7	To learn skills and tools like mathematics, statistics, physics and electronics to find the solution, interpret the results and make predictions for the future developments.	E	1,3,4

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	**Course Description**	**Hrs**	**Hrs**	**CO No.**
1.0	**Numerical Techniques**		**36**	
1.1	Solution of simultaneous linear algebraic equations		2	1,2
1.2	Gauss elimination method - Gauss Jordan method		3	1,3
1.3	Inverse of a matrix using Gauss elimination method		3	3
1.4	Finite differences - forward and backward differences - central differences		3	2,3

1.5	Difference of a polynomial - error propagation in difference table - interpolation with equal intervals	36	3	1,3
1.6	Gregory Newton forward and backward formula		2	2,3
1.7	Error in polynomial interpolation - central difference interpolation formula		3	2,3
1.8	Gauss's forward and backward formula		2	1,3
1.9	Stirling's formula - Lagrange interpolation formula		3	1,2
1.10	Numerical differentiation - numerical integration using general quadrature formula		3	3
1.11	Trapezoidal rile - Simpsons 1/3 and 1/8 rules		2	2,3
1.12	Numerical solutions to ordinary differential equations - Euler and modified Euler methods		3	1,3
1.13	Runge-Kutta methods		2	2
1.14	Numerical solution to partial differential equations - solutions to Poisson and Laplace equations		2	1,2,3
2.0	**Foundations of Computer Science &Programming with C++**	36	**36**	
2.1	Computer architecture - memory and storage - computer languages		3	4
2.2	Operating systems - data communications and computer network databases		3	4
2.3	Internet basics - multimedia		3	4,6
2.4	Features of C++ - basic structure of C++ programs		3	5,6,7
2.5	Header files - in and out functions compilation and execution		3	4,5
2.6	Data types - constants and variables global variables operators and expressions of C++		3	4,5
2.7	Flow control - conditional statements - iterative statements - switch statement		3	4,5
2.8	Conditional operators as an alternative to IF-nested loops-break statement		3	4,5
2.9	Structured data types - arrays - storage classes - multidimensional arrays - sorting of strings		3	4
2.10	Functions - built in and user defined - accessing function and passing arguments to functions - calling functions with arrays - scope rule for functions and variables - structures in C++		3	4,5
2.11	Classes and objects - definition - class declaration - class function definitions - creating objects		3	4,6
2.12	Use of pointers in the place of arrays - file handling in C++		3	5,6
3.0	**Introduction to Python Programming**	18	**18**	
3.1	Python programming basics		3	5,6
3.2	Strings - numbers and operators		3	4,5
3.3	Variables - functions		3	4,5
3.4	Classes and objects		2	4,5
3.5	Organizing programs		3	5,6,7

3.6	Files and directories		2	5,6
3.7	Other features of Python language		2	7

Books for Study

1. V. N. Vedamurty and N.Iyengar, Numerical Methods, Vikas Publishing Pvt. Ltd. (1998)
2. S. S. Sastry, Introductory Method of Numerical Analysis, 5th Edition, PHI Learning Pvt. Ltd. (1984)
3. P. Ghosh, Numerical Methods with Computer Programs in C++, PHI learning Pvt. Ltd. (2009)
4. ITL Education Solutions Ltd, Introduction to Computer Science, 2nd Edition, Dorling Kindersley (India) Pvt. Ltd. (2011)
5. D. Ravichandran, Programming with C++, 3rd Edition, Tata McGraw Hill (2011)
6. M.T. Somasekhara, Programming in C++, PHI Pvt. Ltd. (2005)
7. V. Rajaraman, Fundamentals of Computers, 5th Edition, PHI Pvt. Ltd. (2010)
8. Bjarne Stroustrup, The C++ Programming Language, 4th Edition, Addison Wesley (2013)
9. B. Ram, Computer Fundamentals : Architecture and Organization, 3rd Edition, New Age International Ltd. (2000)
10. Peter Norton, A. Samuel, D. Aitel, E. Foster-Johnson, L. Richardson, J. Diamond, A. Parker and M. Roberts, Beginning Python, Wiley India(P) Ltd. (2005)

Course Details	
Code	**APPY224**
Title	**Relativity and Astrophysics**
Degree	M.Sc.
Branch	Physics
Year/Semester	1/II
Hrs/Week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Acquire knowledge and broad understanding of special theory of relativity	U	1,2,3
2	Ascribe experiments and observational evidences to test the general theory of relativity, explain how these supports the general theory and can be used to criticize and rule out alternative possibilities	Ap	1,2,3
3	Explain that Newton's law of gravitation as an approximation of Einstein's field equation	An	1,2,3
4	Discuss different celestial coordinate systems	R	1,4
5	Identify different terms in astronomy and compare different telescopes	R	1,4,6
6	Apply Stefan-Boltzmann equation to get stellar luminosity	Ap	1,4
7	Analyze stellar spectra	An	1,5
8	Explain different phases of interstellar medium	An	1,5
9	Discuss energy generation in stars	Ap	1,3
10	Explain different phases of stellar evolution	U	1,5,6
11	Classify different types of galaxies and discuss evolution of Universe	U	1,5,6

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	**Course Description**	**Hrs**	**Hrs**	**CO No**
1.0	**Special Theory of Relativity**		**10**	
1.1	Proper time and four-vectors - Minkowski geometry of space-time		2	1
1.2	Lorentz transformation in four - dimensional space		2	1
1.3	Covariant four - dimensional formulation		2	1

1.4	Force and energy - equations in relativistic mechanics	36	1	1
1.5	Lagrangian formulation of relativistic mechanics - Covariant Lagrangian formulation		2	1
1.6	Relativistic energy - momentum tensor for a fluid		1	1
2.0	**General Theory of Relativity**		**18**	
2.1	Non-uniform relative motion - principle of general relativity		2	2
2.2	Principle of equivalence		1	2
2.3	Some applications of the principle of equivalence - equality of inertial mass and gravitational mass - gravitational red shift		2	2
2.4	Curved geometry and metric tensor		2	2
2.5	Covariant differentiation - parallel displacement		1	2
2.6	Riemannian geometry - curvature tensor		1	2
2.7	Bianchi identities - tidal force - geodesic deviation		1	2
2.8	Einstein's field equations		2	2,3
2.9	Weak field approximation - motion of test particle in a weak gravitational field - Poisson's equation from Einstein's law		2	2,3
2.10	Line elements for objects with spherical symmetry		1	2,3
2.11	Schwarzschild solution		1	2,3
2.12	Experimental test - advance of perihelion of mercury - bending of light		2	2,3
3.0	**Introduction to Cosmology**		**8**	
3.1	Expanding Universe		2	4
3.2	Cosmological principle		1	4
3.3	de-Sitter model - Friedmann model		2	4
3.3	The big bang model		2	4
3.4	Steady state model		1	4
4.0	**Measurement of Light**	18	**10**	
4.1	Basic terms in astronomy - flux, luminosity, specific flux, specific luminosity, bolometric luminosity		2	5
4.2	Inverse square law of light		1	5
4.3	Trigonometric parallax as a means to measure distances to nearby stars		1	5
4.4	Definition of a light year - definition of a parsec - apparent magnitude - absolute magnitude		1	5
4.5	Distance relation - signals from astronomical sources		1	5
4.6	Electromagnetic frequencies and photon energies		1	5
4.7	The Earth's atmosphere and transparency to electromagnetic radiation		1	5
4.8	Telescopes (qualitative only) - optical telescopes, radio telescopes, X-ray telescopes		1	5
4.9	Space based observatories with Hubble Space Telescope as an example - its advantages over ground-based telescopes (qualitative only)		1	5

5.0	**Introduction to Stars**		**8**	
5.1	Stars as blackbody - blackbody radiation - Planck's theory of black body radiation		1	6,7
5.2	Planck function - Rayleigh-Jeans and Wien approximations		1	6,7
5.3	Stefan-Boltzmann equation connecting stellar luminosity, radius, and surface temperature		1	6,7
5.4	Spectral classification of stars - absorption and emission spectra - description of how they are produced		1	6,7
5.5	Understanding stellar spectra through Boltzmann equation		1	6,7
5.6	Saha equation of thermal ionization		1	6,7
5.7	Harvard system of classifying stars based on their spectra		1	6,7
5.8	Spectral classes of stars and luminosity classes of stars		1	6,7
6.0	**Interstellar Medium and Formation of Stars**		**8**	
6.1	Phases of the interstellar medium - their physical properties - distribution within the galaxy		1	8
6.2	HII regions and Stromgren sphere		1	8
6.3	Sizes of Stromgren sphere around stars of various spectral type		1	7,8
6.4	Interstellar dust composition - its distribution within the galaxy		1	8
6.5	Extinction and reddening of star light due to dust		1	8
6.6	Virial theorem		1	8
6.7	Jeans criterion for gravitational collapse		1	8
6.8	Free-fall time scale as time-scale for star formation		1	8
7.0	**Stellar Nucleosynthesis**		**8**	
7.1	Energy generation mechanism in stars - nuclear fusion		2	9
7.2	Mass defect - p-p chain - CNO cycle		2	9
7.3	Energy generated from p-p chain and CNO cycle		1	9
7.4	Energy transport within stars (conduction, convection, radiation)		2	9
7.5	Time-scale for energy transport within stars - nuclear time scale		1	9
8.0	**Stellar Evolution**		**10**	
8.1	Hydrostatic equilibrium in stars - pressure equation of state		1	10
8.2	The Hertzsprung - Russell diagram, and the concept of main sequence	**36**	1	10
8.3	Post main-sequence evolution (qualitative)		1	10
8.4	He burning and subsequent stages of nuclear burning in stars		1	10
8.5	Evolution of low mass stars		1	10
8.6	Electron degeneracy pressure		1	10
8.7	White dwarfs - planetary nebulae		1	10
8.8	Evolution of high mass stars - supernova		1	10
8.9	Neutron degeneracy pressure - neutron star		1	10
8.10	Black holes and Schwarzschild radius		1	10
9.0	**Milky Way Galaxy**		**10**	
9.1	The components of the milky way (qualitative based on observational evidence)		1	10, 11

9.2	The galactic disk (young thin disk, old thin disk, thick disk, scale height, the distribution of stars and interstellar gas)		1	10,11
9.3	Galactic bulge		1	11
9.4	Stellar halo		1	11
9.5	Size and shape of the galaxy		1	11
9.6	Open star clusters and globular star clusters		1	11
9.7	Kinematics of the galaxy		1	11
9.8	Differential rotation - rotation curve of the galaxy		1	11
9.9	Evidence for dark matter halo		1	11
9.10	Galactic center - observational evidences for the presence of super massive black hole in the galactic center		1	11

Books for Study

1. K.D. Krori, Fundamentals of Special and General Relativity, Revised Edition, PHI Learning Pvt. Ltd (2010)
2. S. K. Srivastava, General Relativity and Cosmology, PHI learning Pvt. Ltd. (2008)
3. R. K. Pathria, The Theory of Relativity, 2nd Edition, Dover Publications (2003)
4. Jayant V. Narlikar, An Introduction to Relativity, Cambridge University Press (2010)
5. S.P Puri, General theory of Relativity, Pearson Education India (2013)
6. Arnab Rai Choudhuri, Astrophysics for Physicists, Cambridge University Press (2010)
7. Baidyanath Basu, An Introduction to Astrophysics, 2nd Edition, PHI Learning Private Ltd. (2010)
8. Bradley W. Carroll, and Dale A. Ostlie, An Introduction to Modern Astrophysics , 2nd Edition, Pearson Education Ltd. (2006)
9. Hannu Karttunen, Pekka Kröger, Heikki Oja, Fundamental Astronomy, 5th Edition, Springer Berlin Heidelberg, New York (2007)
10. Jayant V. Narlikar, An Introduction to Cosmology, 3rdEdition, Cambridge University Press (2002)
11. Steven Weinberg, Gravitation and Cosmology: Principles and Applications of the General Theory of Relativity, John Wiely& Sons (1971)

Course Details	
Code	**APPY321**
Title	**Quantum Mechanics - II**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/III
Hrs/Week	4
Total hours	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Analyse optical phenomena based on time dependent perturbation theory	An	1,2,3, 6
2	Establish an idea on the many electron system using quantum mechanical concepts	U	1,2,3,6
3	Solve numerical problems related to scattering cross section	Ap	1,2,3,6
4	Explain the formalism of relativistic quantum field theory and the relativistic quantum mechanical equations	E	1,2,3,6
5	Describe field quantization and related concepts	An	1,2,3,6
6	Solve numerical problems related to advanced quantum mechanical concepts like the field equations	Ap	1,2,3,6

PSO-Program specific outcome; CO-Course Outcome

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CONo
1.0	**Time Dependent Perturbation Theory**		**10**	
1.1	First order perturbation		2	1,6
1.2	Harmonic perturbation		2	1,6
1.3	Transition to continuous states		1	1,6
1.4	Absorption and emission of radiation		1	1,6
1.5	Einstein’s coefficients		1	1,6
1.6	Selection rules		1	1,6
1.7	Rayleigh scattering		1	1,6
1.8	Raman scattering		1	1,6
2.0	**Many Electron Atoms**		**14**	
2.1	Indistinguishable particles		2	2,6

2.2	Pauli principle	**36**	2	2,6
2.3	Inclusion of spin		2	2,6
2.4	Spin functions for two and three electrons		2	2,6
2.5	Helium atom		2	2,6
2.6	Central field approximation		1	2,6
2.7	Thomas-Fermi model of the atom		1	2,6
2.8	Hatree equation		1	2,6
2.9	Hatree Fock equation		1	2,6
3.0	**Quantum Theory of Scattering**		**12**	
3.1	Scattering cross section and scattering amplitude		2	3
3.2	Partial wave analysis and scattering by a central potential		2	3
3.3	Scattering by attractive square well potential		2	3
3.4	Scattering length		2	3
3.5	Expression for phase shifts		1	3
3.6	Born approximation		1	3
3.7	Scattering by Coulomb potential		1	3
3.8	Laboratory and centre of mass coordinate transformations		1	3
4.0	**Relativistic Quantum Mechanics**		**22**	
4.1	Klein-Gordon equations and its relevance		2	4,6
4.2	Particle in a Coulomb’s field		2	4,6
4.3	Dirac’s relativistic theory		2	4,6
4.4	Dirac’s equation for a free particle		2	4,6
4.5	Dirac matrices		2	4,6
4.6	Covariant form of Dirac’s equations		2	4,6
4.7	Probability density		2	4,6
4.8	Plane wave solutions		2	4,6
4.9	Negative energy states		1	4,6
4.10	Spin in Dirac’s theory		1	4,6
4.11	Magnetic moment of an electron		1	4,6
4.12	Relativistic corrections of hydrogen atom spectrum		1	4,6
4.13	Spin orbit correction	**36**	1	4,6
4.14	Lamb shift		1	4,6
5.0	**Elements of Field Quantization**		**14**	
5.1	Concepts of classical mechanics		2	5,6
5.2	Classical field equation		2	5,6
5.3	Langrangian and Hamiltonian form		2	5,6
5.4	Quantization of field		2	5,6
5.5	Quantization of Schrodinger equation		1	5,6
5.6	Relativistic fields		1	5,6
5.7	Klein-Gordon field		1	5,6
5.8	The Dirac field		1	5,6
5.9	Classical theory of electromagnetic fields		1	5,6
5.10	Quantization of electromagnetic field		1	5,6

Books for Study

1. G. Aruldhas, Quantum Mechanics, 2nd Edition, PHI learning Pvt. Ltd. (2009)
2. P. M. Mathews and K. Venkitesan, A Text Book of Quantum Mechanics, 2nd Edition, Tata McGraw Hill (2010)
3. J. J. Sakurai, Advanced Quantum Mechanics, Pearson Education Inc.(2009)
4. L. H. Ryder, Quantum Field Theory, 2nd Edition, Cambridge University Press (1996)
5. L. D. Landau,E. M .Lifshitz, Quantum Mechanics: Non-Relativistic Theory, Course of Theoretical Physics: Volume 3,3rd Edition, Pergamon Press (1981)
6. Nouredine Zettili, Quantum Mechanics: Concepts and Applications, 2nd Edition, John Wiley & Sons Ltd.(2009)
7. Walter Greiner, Quantum Mechanics: An Introduction, Springer-Verlag (1989)
8. Walter A. Harrison, Applied Quantum Mechanics, World Scientific Publishers (2000)
9. Leonard I.Schiff, Quantum Mechanics,4th Edition, McGraw Hill Education (2017)
10. John L. Powell and Bernd Crasemann, Quantum Mechanics, Dover Publications (2015)

Course Details	
Code	**APPY322**
Title	**Atomic and Molecular Physics**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/III
Hrs/Week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Understand the principles behind the various aspects of spectroscopy and apply them to real life problems	U, Ap	1,4
2	Understand the techniques like microwave spectroscopy, IR spectroscopy, NMR spectroscopy, Raman spectroscopy, UV-Visible spectroscopy and photoluminescence spectroscopy	U, R	1,4,5
3	Identify the suitable method for a particular application	Ap	4
4	Identify functional groups and molecular species	Ap, An	4,6
5	Classify various types of molecules	Ap, An	4,6

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	**Course Description**	**Hrs**	**Hrs**	**CO No.**
1.0	**Atomic Spectra**		**9**	
1.1	Hydrogen spectrum		1	1
1.2	Larmor precession – angular momentum		1	1
1.3	Vector atom model - spin orbit interaction		1	1,2
1.4	Spectra of alkali atoms - angular momentum of many electron atoms		1	6
1.5	Energy levels and spectral transitions of helium		1	1,2
1.6	Spectral terms of equivalent electrons		1	2,3
1.7	Normal Zeeman effect - anomalous Zeeman effect - Paschen Back effect		1	1,2,3
1.8	Influence of nuclear spin - hyperfine structure		1	2
1.9	Stark effect – Rydberg atoms - Lamb shift		1	3
2.0	**Molecular Rotational Spectroscopy**	**18**	**9**	
2.1	Classification of molecules		1	1,2
2.2	Rotational spectra of diatomic molecules		1	1,2,3
2.3	Isotope effect and intensity of rotational lines		1	2,6
2.4	Non-rigid rotator		1	1,2,6
2.5	Linear polyatomic molecules		1	2,4
2.6	Symmetric and asymmetric top molecules - microwave spectrometer		2	1,2,3
2.7	Analysis of rotational spectra		2	2,6
3.0	**IR Spectroscopy**		**10**	

3.1	Vibrational energy of diatomic molecules	36	2	2,3
3.2	Infrared selection rule – vibrating diatomic molecule - anharmonicity		2	1,2
3.3	Vibrations of polyatomic molecules - Fermi resonance - hydrogen bonding		2	4,5
3.4	Normal modes of vibration in a crystal		1	5,6
3.5	Interpretation of vibrational spectra		1	4,5
3.6	Fourier transform IR spectroscopy		2	1,2,3
4.0	**Raman Spectroscopy**		**8**	
4.1	Theory of Raman scattering		2	1,2,3
4.2	Rotational and vibrational Raman spectra		2	3,4
4.3	Raman spectrometer		1	4,5
4.4	Structure determination using Raman and IR spectroscopy		3	5,6
5.0	**UV-Visible and Photoluminescence Spectroscopy**		**6**	
5.1	Measurement of transmittance and absorbance - Beer's law		1	1,2,3
5.2	Absorption by organic and inorganic compounds		2	1,2,3
5.3	Theory of fluorescence and phosphorescence - singlet and triplet excited states		1	1,2,3
5.3	Energy level diagram of photoluminescent molecules - deactivation processes		2	1,2,3
6.0	**Electronic Spectroscopy of Molecules**		**12**	
6.1	Vibrational coarse structure and analysis of bound systems		2	1
6.2	Deslanders table		2	2
6.3	Frank Condon principle		1	4
6.4	Vibrational electronic spectra		2	3,4
6.5	Rotational fine structure		2	2,3
6.6	Fortrat parabola		2	1,2
6.7	Electronic angular momentum in diatomic molecules		1	1,2
7.0	**NMR Spectroscopy**	36	**9**	
7.1	Magnetic properties of nuclei - resonance condition		2	1,2
7.2	NMR instrumentation,		1	2,3
7.3	Chemical shift and factors affecting chemical shift		2	2,3
7.4	Fine structure (spin-spin coupling)		1	1,2
7.5	Relaxation processes (line shapes)		1	4,5
7.6	NMR imaging		1	5,6
7.7	Interpretation of NMR spectra		1	4,5
8.0	**ESR Spectroscopy**		**9**	
8.1	Principle of ESR - ESR spectrometer		2	4
8.2	Hyperfine structure - ESR spectrum of hydrogen atom		1	3,4
8.3	One electron system coupled to nucleus of spin I=1		2	2,3
8.4	Unpaired electron coupling with two equivalent nuclei of spin I= ½		2	1,2
8.5	ESR spectra of free radicals		2	1,2
9.0	**Mossbauer Spectroscopy**		**8**	
9.1	Recoilless emission and absorption		2	2,3
9.2	Mossbauer spectrometer		1	2,3
9.3	Experimental technique		2	1,2
9.4	Isomer shift		1	4,5
9.5	Quadrupole interaction		1	5,6
9.6	Hyperfine interaction		1	4,5
10.0	**Photoelectron and Related Spectroscopies**		**10**	

10.1	Photoelectron spectroscopy		1	2,3
10.2	Experimental methods		2	1,2
10.3	Photoelectron spectra and their interpretation		2	4,5
10.4	Auger electron and X-ray fluorescence spectroscopy		2	5,6
10.5	Photo acoustic effect (basic theory)		2	4,5
10.6	Experimental arrangements - applications		1	5,6

Books for Study

1. H. E. White, Introduction to Atomic Spectra, McGraw Hill Book Company (1934)
2. J. M. Hollas, Modern Spectroscopy, 4th Edition, John Wiley &Sons (2004)
3. G. Aruldhas, Molecular Structure and Spectroscopy, 2nd Edition, PHI learning Pvt. Ltd. (2007)
4. Suresh Chandra, Molecular Spectroscopy, Narosa Publishing Company (2009)
5. C. N. Banwell and E. M. McCash, Fundamentals of Molecular Spectroscopy, 4th Edition,Tata McGraw Hill (1995)
6. D. A. Skoog, F. J. Holler and S. R. Crouch, Instrumental Analysis, Cengage Learning, (2012)
7. N. K. Fuloria and S. Fuloria, Spectroscopy: Fundamentals and Data Interpretation, Studium Press (India) Pvt. Ltd. (2013)
8. D. N. Satyanarayana, Vibrational Spectroscopy-Theory and Applications, New Age International Pvt. Ltd. (2004)
9. J. L. McHale, Molecular Spectroscopy, Pearson Education Inc. (2008).
10. K. Nakamoto, Infrared and Raman Spectra of Inorganic and Coordination Compounds, Part A and Part B, Two Volume Set, 6th Edition, John Wiley & Sons (2008)

Course Details	
Code	**APPY323**
Title	**Statistical Mechanics and Thermodynamics**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/III
Hours/week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Explain statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics	U	1,2,3
2	Describe the basis of ensemble approach in statistical mechanics to a range of situations	Ap	1,3,4
3	Explain the fundamental differences between classical and quantum statistics	U	1,2,3
4	Analyse the link between statistics and thermodynamics, classical and quantum statistics and its applications	An	1,3,4,5
5	Explain thermodynamic behavior of ideal gas, Bose Einstein gas and Fermi Dirac gas and also the applications of statistical mechanics	Ap	1,3,4
6	Identify and solve problems in statistical mechanics using ensemble theory	Ap	1,3,4

PSO - Program specific outcome; CO - Course Outcome
Cognitive Level; R-Remember; U-Understanding; Ap-Apply; An-Analyse; E-Evaluate; C-Creat

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Thermodynamic Relations and Consequences**		**20**	
1.1	Thermodynamic functions and Maxwell's equations		3	1,6
1.2	Clausius-Clapeyron equations		2	1,6
1.3	Properties of thermodynamic potentials		2	1,6
1.4	Gibbs-Helmholtz relation thermodynamic equilibrium		3	1,6
1.5	Nernst heat theorem and its consequences		3	1,6
1.6	Gibb's phase rule		2	1,6
1.7	Chemical potential		2	1,6
1.8	Vapour pressure relation and chemical constants		3	1,6
2.0	**Phase Transitions**	**36**	**16**	
2.1	Triple point		2	1,6
2.2	Van der Waals equation and phase transitions		3	1,6
2.3	First and second order phase transitions		3	1,6
2.4	Ehrenfest's equations		2	1,6
2.5	Ising model - Yang and Lee theory of phase transitions		3	1,6
2.6	Landau theory of phase transitions		3	1,6
3.0	**Foundations of Classical Statistical Physics**		**16**	
3.1	Phase space - ensembles		2	2,3
3.2	Liouville's theorem		2	2,3
3.3	Statistical equilibrium		1	2,3
3.4	Maxwell Boltzmann distribution law		2	2,3
3.5	Microcanonical ensemble		2	2,3
3.6	Partition functions and thermodynamic quantities		2	2,3
3.7	Gibb's paradox		2	2,3
3.8	Gibb's canonical ensemble		2	2,3
3.9	Grand canonical ensemble	**36**	1	2,3
4.0	**Quantum Statistics**		**20**	
4.1	Quantum statistics of identical particles		1	2,3
4.2	Symmetric and anti-symmetric wave functions		1	
4.2	Density matrix – time dependence of density matrix		2	2,3,7
4.3	Density matrix in microcaonical, canonical and grand canonical ensembles		2	3,4,5,7
4.4	Bose Einstein statistics and Bose Einstein distribution law		2	3,4,5,7
4.5	Fermi Dirac statistics and Fermi Dirac distribution law		2	3,4,5,7
4.6	Comparison of three types of statistics		1	3,4,5
4.7	Planck radiation law		2	3,4,5
4.8	Bose Einstein gas and Bose Einstein condensation		2	3,4,5
4.9	Fermi Dirac gas - electron gas in metals - thermionic emission		3	3,4,5
4.10	Statistical theory of white dwarfs		2	3,4,5
5.0	**Quantum Theory of Specific Heat**		**18**	
5.1	Introduction -The Dulong and Petit's law		2	1,6
5.2	Einstein's theory of specific heat of solids		2	1,6
5.3	Debye's theory of specific heat of solids - comparison of the Debye formula with experiments - criticism of Debye's theory		2	1,6
5.4	Born-Karman theory - specific heat of gases	**18**	2	1,6
5.5	Variation of specific heat of diatomic gases with temperature		2	1,6

5.6	Quantisation of rotational motion and its contribution to specific heat		2	1,6
5.7	Quantisation of vibrational motion and its contribution to specific heat		3	1,6
5.8	Calculation of specific heat of hydrogen - variation of specific heat of hydrogen		3	1,6

Books for Study

1. Satya Prakash, Statistical Mechanics, Kedar Nath Ram Nath Publishers, Meerut and Delhi (2009)
2. R. K. Srivastava and J. Asok, Statistical Mechanics, Wiley Easter Ltd. (2005)
3. S. K. Sinha, Statistical Mechanics – Theory and Applications, Tata McGraw Hill (1990)
4. Kerson Huang, Statistical Mechanics,2^{nd} Edition, John Wiley &Sons (2003)
5. S. L. Gupta, V. Kumar, Elementary Statistical Mechanics, Pragati Prakasan Publishers (2019)
6. R. K. Pathria, Statistical Mechanics, 2^{nd} Edition, Butterworth-Heinemann (1996)
7. B. K. Agarwal and M.Eisner, Statistical Mechanics, Wiley Eastern (1989)

Course Details	
Code	**APPY324.1**
Title	**Advanced Electronics - I**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/III
Hrs/Week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Understand the principles behind the various communication systems, like, microwave radio communication, digital communication, optical fiber communication, mobile cellular communication and design the respective systems	U, Ap	3,5,6
2	Identify the modulation techniques, namely, AM, FM, angle modulation, pulse modulations and binary ASK, FSK and PSK schemes that are used in analog and digital communication systems	U	3,6
3	Identify the different multiplexing techniques	U	3,6
4	Identify the various types of signals and classify them	An	3,5,6
5	Classify the various systems used in digital signal processing and design the irrespective representations	An	3,2,5
6	Apply Fourier transform and z-transform to digital signal processing	Ap	3,5
7	Evaluate the output signals from the transfer function of systems	E	2,3
8	Design FIR and IIR digital filters	Ap	2, 5,6

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Creat

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Analog Signal Transmission**	**18**	**10**	
1.1	Types of analog continuous wave modulation - analog base band signal transmission - signal distortions in base band transmission - equalization		2	1
1.2	Linear continuous wave modulation schemes - DSB modulation		1	1
1.3	Amplitude modulation		1	1,2
1.4	SSB modulation		1	1,2
1.5	Frequency conversion		1	1,2
1.6	Angle modulation - spectra of angle modulated signals		1	1,2
1.7	Power and bandwidth of FM signals		1	1,2
1.8	Generation and demodulation of FM signals		2	1,2
2.0	**Microwave Radio Communication**		**8**	
2.1	Advantages and disadvantages of microwave radio communications		1	1,2
2.2	Digital and analog systems		1	1,2
2.3	Frequency and amplitude modulation techniques		2	1,2
2.4	FM microwave radio system		2	1,2
2.5	FM microwave repeaters		1	1,2
2.6	Line of sight path characteristics		1	1,2
3.0	**Pulse Modulation**	**36**	**6**	
3.1	Pulse analog modulation techniques - pulse amplitude modulation (PAM)		1	2
3.2	Pulse width modulation (PWM) - pulse position modulation (PPM)		1	2
3.3	Demodulation of pulse analog modulated signals		1	2
3.4	Pulse digital modulation techniques - pulse code modulation		1	2
3.5	Delta modulation - differential PCM (DPCM)		1	2
3.6	Demodulation of pulse digital modulated signals		1	2
4.0	**Digital Communication**		**14**	
4.1	Basics of information theory - ideas of digital codes		2	1
4.2	Noise in information carrying channel		1	1
4.3	Digital carrier modulation schemes - binary ASK, PSK and FSK schemes		5	1,2
4.4	Bandwidth and power requirements - synchronization methods		1	1,2
4.5	Ideas of error control coding and error corrections		2	2
4.6	Digital transmission of analog signals - transmission using PCM		1	2
4.7	Frequency division multiplexing (FDM)		1	3
4.8	Time division multiplexing (TDM)		1	3
5.0	**Optical Fiber Communications**		**16**	
5.1	Overview of optical communication systems - elements of an optical fiber transmission link		2	1
5.2	Fundamental receiver operation - digital signal transmission		1	1

5.3	Error sources - receiver configuration		1	1
5.4	Digital receiver performance calculation - probability of error		2	1
5.5	Coherent optical fiber communication - definition and classification of coherent systems		1	1
5.6	Fundamental concepts - homodyne detection - heterodyne detection		1	1
5.7	Modulation techniques - direct detection OOK - OOK homodyne system - PSK homodyne system - heterodyne detection schemes		2	1
5.8	WDM and CDM in optical communication		3	1,3
5.9	Fiber solitons		1	1
5.10	Soliton based communication		2	1
6.0	**Mobile Cellular Communications**		**8**	
6.1	Mobile telephone services - cellular telephone - frequency reuse - cell splitting		1	1
6.2	Sectoring - segmentation and dualization		1	1
6.3	Cellular system topology - roaming and handoffs		1	1
6.4	Cellular telephone network components and call processing		1	1
6.5	First and second generation cellular telephone services		1	1
6.6	Digital cellular telephone system		1	1
6.7	Global system for mobile communication		1	1
6.8	Personal satellite communication system		1	1
7.0	**Basics of Signals and Systems**		**6**	
7.1	Classification of signals		1	4
7.2	Amplitude and phase spectra - simple manipulations of discrete time signals	**36**	1	4
7.3	Classification of systems		1	5
7.4	Representation of systems		1	5
7.5	Analog to digital conversion of signal		2	4,5
8.0	**Fourier Analysis of Signals and Systems**		**8**	
8.1	Fourier analysis of signals and systems - trignometric Fourier series - exponential form		1	6
8.2	Parseval’s identity-power spectrum of a periodic function		1	6
8.3	Fourier transform - properties of Fourier transform		2	6
8.4	Fourier transform of important signals		2	6
8.5	Fourier transform of power and energy signals		1	6
8.6	Discrete time Fourier transform - fast Fourier transform		1	6
9.0	**z-Transform**		**8**	
9.1	Definition of z-transform		2	6
9.2	Properties of z-transform		3	6
9.3	Evaluation of the inverse z-transform		3	6
10.0	**Digital Filters**		**6**	
10.1	Finite impulse response (FIR) digital filters - magnitude and phase response of digital filters		1	7
10.2	Frequency response of linear phase FIR filters		1	7

10.3	Design techniques of FIR filters		3	7
10.4	Ideas of infinite impulse response (IIR) filters		1	7

Books for Study

1. K. Sam Shanmugam, Digital and Analog Communication Systems, John Wiley & Sons, NewDelhi (2013)
2. W. Tomasi, Electronic Communications Systems: Fundamentals Through Advanced, 5th Edition , Dorling Kinderley (India) Pvt. Ltd. (2013)
3. G. Kennedy, B. Davis and S. R. M. Prasanna, Electronic Communication Systems, 5thEdition, McGraw Hill Education (India) Pvt. Ltd. New Delfh (2014)
4. D. Roddy and J. Coolen, Electronic Communications, 4th Edition, Prentice Hall of India, NewDelhi (1995)
4. G. Keiser, Optical Fibre Communications,5 th Edition, Tata McGraw Hill, NewDelhi (2013)
5. G. P. Agrawal, Fibre Optic Communication Systems, 4th Edition, John Wiley & Sons (2010)
6. S .Salivahanan, A. Vallavaraj and G. Ganapriya, Digital Signal Processing, 2nd Edition, Tata McGraw Hill, New Delhi(2010)
7. H. Taub, D. Schilling and G. Saha, Principle of Communication systems, 3rd Edition, Tata McGraw Hill, New Delhi (2012)
8. W. C. Y. Lee, Mobile Communications Design Fundamentals, 2nd Edition, John Wiley & Sons, NewYork(1993)
9. J. S. Chitode, Digital Communications, Technical Publications, Pune (2008)
10. J. M. Senior, Optical Fibre Communications: Principles and Practice, 3rd Edition, Pearson Education (2009)
11. J. J .Carr, Microwave and Wireless Communications Technology, Butterworth-Heinemann (1996)

Course Details	
Code	**APPY324.2**
Title	**Theoretical Physics - I**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/III
Hours/week	5
Total hours	90

CO No.	Expected Course Outcome *Upon completion of this course, the student will be able to:*	Cognitive Level	PSO No.
1	Explain the concepts of advanced theoretical physics covering relativistic quantum mechanics, quantum field theory, stochastic processes and general theory of relativity	U	1,2,3
2	Identify and solve introductory level problems in relativistic quantum mechanics and field theory	Ap	1,3,6
3	Describe the basic theory of stochastic processes with emphasize on non-equilibrium systems	U, An	1,3,6
4	Identify the different types of groups and symmetry operations	U, R	1,2
5	illustrate formalism of general theory of relativity	Ap	1,2,3

PSO – Program specific outcome; CO – Course outcome
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Formalism of Quantum Mechanics**	**36**	**10**	
1.1	Linear vector space - linear operators		1	1,2
1.2	Normed spaces - Hilbert spaces		1	1,2
1.3	Self- adjoint operators		2	1,2
1.4	Representation of operators and states in suitable basis		2	1,2
1.5	Spectral properties of self-adjoint operators		2	1,2
1.6	Spectral theorem		2	1,2
2.0	**Groups and Symmetry**		**12**	
2.1	Review of groups - Irreducible representations of groups		1	1,4
2.2	Discrete and continuous groups		1	1,4
2.3	Lie groups - Lie algebra		1	1,4
2.4	How symmetries form a group		1	1,4
2.5	Unitary and anti-unitary symmetry operators		1	1,4
2.6	Rotation and O(3) group		1	1,4

2.7	SU(2) group		1	1,4
2.8	Angular momentum algebra		1	1,4
2.9	Vector operators - tensor operators		1	1,4
2.10	Wigner-Eckart theorem		1	1,4
2.11	Discrete symmetries space and time inversion symmetries		2	1,4
3.0	**Relativistic Quantum Mechanics**		**6**	
3.1	Lorentz group - generators		2	1,2
3.2	Representation of Lorentz group extended by parity and Dirac equation		2	1,2
3.3	Hydrogen atom		2	1,2
4.0	**Field Theory**		**8**	
4.1	Lagrangian formalism		2	1,2
4.2	Noether's theorem		2	1,2
4.3	Hamiltonian density		1	1,2
4.4	Quantization of fields		1	1,2
4.5	Second quantization, quantization of EM field		2	1,2
5.0	**Statistical Physics – Stochastic Processes**	**36**	**18**	
5.1	Review of probability and measure		2	1,3
5.2	Equilibrium vs non-equilibrium		3	1,3
5.3	Brownian motion		2	1,3
5.4	Langevin equation		2	1,3
5.5	Ito vs Stratonovich		2	1,3
5.6	Markov processes		2	1,3
5.7	Fokker-Planck equation		2	1,3
5.8	Fluctuation-dissipation theorem		3	1,3
6.0	**Special Topics in Non-equilibrium Systems**		**18**	
6.1	Einstein diffusion equation		5	1,3
6.3	Derivation and boundary conditions		4	1,3
6.3	Free diffusion in onedimensional half-space		4	1,3
6.4	Fluorescence micro photolysis		5	1,3
7.0	**Differential geometry**	**18**	**8**	
7.1	Tensors		2	1,5
7.2	Differentiable manifolds		2	1,5
7.3	Geodesics- curvature		2	1,5
7.4	Riemannian tensor		2	1,5
8.0	**General Theory of Relativity**		**10**	
8.1	Principle of equivalence		2	1,5
8.2	Einstein equations		2	1,5
8.3	Centrally symmetric gravitational fields		2	1,5
8.4	Schwarzschild solution		2	1,5
8.5	Singularities		2	1,5

Books for Study

1. F. Scheck, Quantum Physics, Springer (2007)
2. G. Teschl, Mathematical Methods in Quantum Mechanics: With Applications to Schrodinger Operators, 2nd Edition, American Mathematical Society (2014)
3. P. Szekeres, Modern Mathematical Physics, Cambridge University Press (2004)
4. M. T. Vaughn, Introduction to Mathematical Physics, Wiley - VCH Verlag (2007)
5. G. B. Arfken, H. J. Weber and F. E. Harris, Mathematical Physics for Physicists, 7th Edition, Academic Press (2012)
6. J. J. Sakurai, Modern Quantum Mechanics, Addison-Wesley Publishing Company (1994)
7. L. I. Schiff, Quantum Mechanics, McGraw-Hill Book Co. (1968)
8. R. Shankar, Principles of Quantum Mechanics, Springer (1994)
9. L. E. Ballentine, Quantum Mechanics, World Scientific Publishing Co. (2000)
10. L. H. Ryder, Quantum Field Theory, Cambridge University Press (2008)
11. J. J. Sakurai, Advanced Quantum Mechanics, Addison-Wesley (1967)
12. M. Le Bellac, Quantum and Statistical Field Theory, Oxford University Press (2001)
13. K. Schulten and I. Kosztin, Lectures in Theoretical Biophysics, University of Illinois at Urbana- Champaign (2000)
14. R. Kubo, M. Toda and N. Hashitsume, Statistical Physics II: Non equilibrium Statistical Mechanics, Springer-Verlag (1985)
15. G. F. Mazenko, Non equilibrium Statistical Mechanics, Wiley-VCH Verlag (2006)
16. V. Balakrishnan, Elements of Non equilibrium Statistical Mechanics, CRC Press (2008)
17. B. F. Schutz, A First Course in General Relativity, Cambridge University Press (2009)
18. S. Caroll, Space time and Geometry: An Introduction to General Relativity, Addison Wesley (2004)
19. A. Altland and B. Simons, Condensed Matter Field Theory, Cambridge University Press (2008)
20. J. W. Negele and H. Orland, Quantum Many-particle Systems, Levant Books (2006)
21. E. Fradkin, Field Theories of Condensed Matter Systems, Levant Books (2006)
22. P. M. Chaikin and T. C. Lubensky, Principles of Condensed Matter, Physics, Cambridge University Press (2004)
23. A. M. Tsvelik, Quantum Field Theory in Condensed Matter Physics, Cambridge University Press (2003)

Course Details	
Code	**APPY421**
Title	**Nuclear and High Energy Physics**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/IV
Hrs/Week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Recognize different types of nuclei, their properties and structure	R	1,3
2	Understand the basic properties of nuclear forces	U	1,2
3	Compare major models of the nucleus and analyze their merits and demerits	An	1,3
4	Explain the construction and working of various nuclear detectors and particle accelerators	E	1,3,6
5	Evaluate the physics of nuclear reactions	E	3,4
6	Differentiate nuclear fission and fusion reactions and to understand the working of nuclear reactors	An	1,6
7	Differentiate elementary particles and discuss their interactions	An	3,5,6
8	Apply the knowledge of nuclear physics to various practical fields	Ap	1,5,6

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	**Course Description**	**Hrs**	**Hrs**	**CO No.**
1.0	**Nuclear Forces**		**10**	
1.1	Deuteron - properties and simple theory of deuteron structure		2	1,2
1.2	Neutron-proton scattering and proton-proton scattering at low energies		2	1,2,5
1.3	Spin dependence		1	2,5
1.4	Non-central forces and tensor nature		2	2,5,8
1.5	Nuclear exchange force		1	1,2,5

1.6	Meson theory of nuclear forces	36	2	**2,5**
2.0	**Nuclear models**		**12**	
2.1	Liquid drop model - basics		1	**1,3**
2.2	Semi empirical mass formula		2	**1,3**
2.3	Magic numbers and nuclear shell model - basic ideas		1	**1,3**
2.4	Shell model potential and spin orbit interaction		2	**1,3,5**
2.5	Spins and parities		1	**2,3,5**
2.6	Magnetic dipole moments and electric quadrupole moments		1	**1,3,5**
2.7	Collective model of the nuclei		2	**3**
2.8	Nuclear rotations and vibrations		2	**1,5**
3.0	**Nuclear reactions**		**14**	
3.1	Conservation laws		1	**1,2,5**
3.2	Energetics of nuclear reactions - Q value equation		2	**1,5**
3.3	Partial wave analysis of nuclear reaction cross section		2	**1,2,5**
3.4	Compound nuclear hypothesis		1	**2,5**
3.5	Resonance reactions		2	**1,2,5**
3.6	Breit-Wigner one level formula		2	**1,2,5**
3.7	Optical model		2	**2,3,8**
3.8	Theory of stripping reactions		2	**2,5**
4.0	**Nuclear Fission**	18	**10**	
4.1	Mechanism of nuclear fission		1	**1,6**
4.2	Calculation of critical energy based on liquid drop model		2	**2,3,5**
4.3	Fission products and energy release		1	**5,6,8**
4.4	Fission chain reactions		2	**5,6**
4.5	Neutron cycle and four factor formula		2	**1,5**
4.6	General features and classification of nuclear fission reactors		2	**6,8**
5.0	**Nuclear Fusion**		**8**	
5.1	Nuclear fusion in stellar interiors		1	**1,6,8**
5.2	Proton-proton reaction and carbon-nitrogen cycle		1	**1,5,8**
5.3	Thermo nuclear reactions in the laboratory		1	**5,6**
5.4	Conditions for construction of nuclear fusion reactor		1	**6,8**
5.5	Critical ignition temperature and Lawson criterion		1	**1,5**
5.6	Plasma confinement in fusion		1	**6**
5.7	Principles of pinch		1	**5,6**
5.8	Magnetic and inertial confinements		1	**8**
6.0	**Nuclear Detectors and Particle Accelerators**	36	**20**	
6.1	Gas filled detectors		1	**4,8**
6.2	Ionization chamber and proportional counters		2	**4,8**
6.3	GM counter		1	
6.4	Scintillation detectors		1	**4,8**
6.5	Semiconductor detectors		2	**4,8**
6.6	Cerenkov detector		1	**4,8**
6.7	Bubble chamber		1	**4,8**
6.8	Particle accelerators		1	**4,8**

6.9	Electrostatic accelerators		2	**4,8**
6.10	Cyclotron accelerator		2	**4,8**
6.11	Synchrotrons		2	**4,8**
6.12	Linear accelerators		2	**4,8**
6.13	Colliding beam accelerators		2	**4,8**
7.0	**Elementary Particle Physics**		**16**	
7.1	Elementary particle interactions		2	**5,7**
7.2	Symmetries and conservation laws		2	**5,7**
7.3	Quark model of elementary particles		3	**5,7**
7.4	Colored quarks and gluons		2	**5,7**
7.5	Ideas of charm, beauty and truth		2	**5,7**
7.6	Quark dynamics		2	**5,7**
7.7	Ideas of grand unified theories of fundamental forces		3	**2,5,7**

Books for Study

1. D.C. Tayal, Nuclear Physics, 5th Edition, Himalaya Publishing Company (2009)
2. K. S. Krane, Introductory Nuclear Physics, Wiley India Pvt. Ltd. (1988)
3. J. Varma, R. C. Bhandari, D. R. S . Somayajulu, Fundamentals of Nuclear Physics, CBS Publishers and Distributors (2005)
4. S.B. Patel, Nuclear Physics - An Introduction, New Age International Pvt. Ltd. (1996)
5. B. R. Martin, Nuclear and Particle Physics - An Introduction, 2nd Edition, Wiley India Pvt. Ltd. (2012)
6. S. N. Ghoshal, Nuclear Physics, S.Chand Ltd (1997)
7. M. P. Khanna, Introduction to Particle Physics, PHI Pvt. Ltd. (2011)
8. Y. Neeman and Y. Kirsh, The Particle Hunters, 2nd Edition, Cambridge University Press (1996)
9. J. Freidberg, Plasma Physics and Fusion Energy, Cambridge University Press (2007)
10. F. F. Chen, Introduction to Plasma Physics, Springer, London (2002)
11. G. F. Knoll, Radiation Detection and Measurement, 4th Edition, Wiley (2010)
12. S. S. Kapoor and V.S. Ramamurthy, Nuclear Radiation Detectors, Wiley (2005)
13. K. Muraleedhara Varier, Nuclear Radiation Detection, Measurements and Analysis, Narosa Publishing House (2009)
14. K. Muraleedhara Varier, Antony Joseph and P. P. Pradyumnan, Advanced Experimental Techniques in Modern Physics, Pragati Prakashan, Meerut (2006)

Course Details	
Code	**APPY422**
Title	**Condensed Matter Physics**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/IV
Hrs/Week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course , the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Recognize different types of crystalline materials and their structural classification	R	1,3
2	Explain the free electron theory of metals and F-D distribution function	U	1, 3
3	Interpret the band theory of solids	Ap	1,4
4	Explain lattice vibrations and thermal properties of solids	E	1,3
5	Analyze the theory of dielectrics	An	5
6	Analyze the theory of ferroelectrics		
7	Explain the magnetic properties of materials		1,4,5
8	Explain the superconductivity behavior in materials	An	1, 4
9	Solve numerical problems related to metals, and their different properties like dielectric, magnetic and superconducting.	Ap	2,4,6

PSO - Program specific outcome; CO - Course Outcome

Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Crystalline State**	**18**	**18**	
1.1	Symmetry operations - point operations - hybrid operations		2	1,9
1.2	Two dimensional and three dimensional crystal lattices		2	1,9
1.3	Indices of a lattice direction and a lattice plane - space groups - elements of quasi crystals		2	1,9
1.4	Free electron theory of metals - The Drude model - electrical conductivity of metals		2	1,2
1.5	DC conductivity - AC conductivity - magneto conductivity - Hall effect		2	2,9

1.6	Thermal conductivity of metals- Lorentz modification of the Drude model		2	1,2,9
1.7	Fermi-Dirac distribution function		2	1,2
1.8	The density of states - free electron gas - electron heat capacity		2	2
1.9	The Sommerfeld theory of electric conduction in metals		2	2,9
2.0	**Electron Energy Bands**	**18**	**18**	
2.1	Consequence of periodicity		2	3
2.2	Proof of Bloch theorem - periodicity of Bloch functions and their eigen values		3	3,9
2.3	Wave mechanical interpretation of energy bands		2	3,9
2.4	Kronig-Penney model - the nearly free electron model		3	3
2.5	Zone scheme for energy bands - energy bands in general periodic potential		3	3
2.6	Distinction between conductors, semiconductors and insulators - tight binding approximation		3	3,9
2.7	The Wigner-Seitz cellular method		2	3,9
3.0	**Lattice Vibrations and Thermal Properties of Solids**	**18**	**18**	
3.1	Normal modes of one-dimensional monatomic chain		2	2,3,4
3.2	Periodic boundary condition and dispersion curves		2	2,3,4
3.3	Normal modes of one-dimensional diatomic chain and dispersion		1	2,3,4
3.4	The reststrahlen band - general theory of harmonic approximation		2	3,4
3.5	Normal modes of real crystals - quantization of lattice vibrations - measurement of phonon dispersion by inelastic neutron scattering		2	2,3,4
3.6	Classical lattice heat capacity - quantum theory of lattice heat capacity		1	4,9
3.7	Average thermal energy of a harmonic oscillator - Einstein model - phonon density of states		2	4,9
3.8	Debye continuum model - Free carrier contribution to heat capacity		2	4,9
3.9	Anomalous heat capacity - anharmonic effects		2	4,9
3.10	Thermal expansion - phonon collision processes - phonon thermal conductivity		2	4,9
4.0	**Properties of Solids – Theory of Dielectrics**		**36**	
4.1	Polarization - dielectric constant - local electric field – dielectric polarizability		2	5,9
4.2	Sources of polarizability - electronic, ionic and orientational polarization - polarization from dipole orientation		2	5,9
4.3	Dielectric loss - optical phenomena		1	5,9
4.4	Applications to plasma - application to optical phonon modes in ionic crystals		2	5,9

4.5	Ferroelectric crystals - crystal types - theory of ferroelectric displacive transitions		1	6,9
4.6	Thermodynamic theory of ferroelectric transitions - ferroelectric domains		2	6,9
4.7	Anti-ferroelectricity - piezoelectricity – electrostriction - applications of piezo electric crystals		2	6,9
4.8	Magnetic properties - theory of Atomic magnetic moment	**36**	1	7,9
4.9	Hund's rules - quantum theory of magnetic susceptibility - diamagnetism - paramagnetism		2	7,9
4.10	Applications to magnetic ions in solids - Van Vleck paramagnetism - Pauli paramagnetism - nuclear paramagnetism		2	7,9
4.11	Cooling by adiabatic demagnetization		1	7,9
4.12	Magnetic resonance - electron spin resonance - nuclear magnetic resonance - spin relaxation		2	7,9
4.13	Weiss theory of ferromagnetism - the exchange interaction - the Heisenberg model - ferromagnetic domains		2	7,9
4.14	Neel model of antiferromagnetism - Neel model of ferrimagnetism		2	7,9
4.15	Spin waves - magnons in ferromagnets		2	7,9
4.16	The Bloch $T^{3/2}$ law – magnons in antiferromagnets - GMR and CMR materials		2	7,9
4.17	Superconducting properties - the London and Ginzburg -Landau equations		2	8,9
4.18	The coherence length - flux quantization and fluxoids		2	8,9
4.19	Order of magnitude for coherence length		2	8,9
4.20	Giaever tunneling - Josephson junction tunneling - SQUID		2	8,9

Books for Study

1. J. P. Srivatava, Elements of Solid State Physics, PHI Learning Pvt. Ltd., Delhi (2015)
2. James D. Patterson and Bernard C. Bailey, Solid State Physics: Introduction to the Theory, Springer USA (2007)
3. Charles Kittel, Introduction to Solid State Physics, Wiley, Indian reprint (2015)
4. A. J. Dekker, Solid State Physics, Macmillan & Co. Ltd. (1967)
5. L. V. Azaroff, Introduction to Solids, McGraw Hill Book Company, New York (1960)
6. M. A. Wahab, Solid State Physics – Structure and Properties of Materials, 2nd Edition, Alpha Science International (2005)
7. S. O. Pillai, Solid State Physics ,6th Edition, NewAge Science (2009)
8. M. Ali Omar, Elementary Solid State Physics: Principles and Applications, Revised Edition, Addison-Wesley Publishing Company (1993)
9. E.A. Lynton, Superconductivity, 2nd Edition, Methuen & Co. Ltd., London (1969)
10. J.S. Blackmore, Solid State Physics, 2nd Edition, Cambridge University Press (1986)

Course Details	
Code	**APPY423**
Title	**Semiconductor Physics and Nanoelectronics**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/IV
Hrs/Week	4
Total hours	72

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Explain the basic properties of semiconductors including the band gap, charge carrier concentration, doping and charge carrier injection/excitation.	R	1,3,4,6
2	Explain the working, design considerations and applications of various semiconducting devices including p-n junctions, BJTs and FETs	U	2,3,4
3	Describe the working and design considerations for the various photonic devices like photodetectors, solar - cells and LEDs	Ap	2,3,4
4	Explain the design and working of nanoelectronic devices	E	2,4,5
5	Interpret the concept of spintronics and quantum computing	An	1,4,5,6
6	Solve numerical problems related to metals and their different properties like dielectric, magnetic and superconducting	E	1,6

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	**Course Description**	**Hrs**	**Hrs**	**CO No.**
1.0	**Semiconductors in Equilibrium**	**18**	**18**	
1.1	Charge carriers in semiconductors		1	1,6
1.2	Equilibrium distribution of electrons and holes - The n_o and p_o equations		2	1,6
1.3	The intrinsic carrier concentration - the intrinsic Fermi-level position		2	1,6
1.4	Dopant atoms and energy levels - ionization energy		2	1,6

1.5	Group III–V semiconductors		2	1,6
1.6	The extrinsic semiconductor – equilibrium distribution of electrons and holes- the nopo product		2	1,6
1.7	Carrier transport phenomena - carrier drift - drift current density - mobility effects		3	1,6
1.8	Conductivity - velocity saturation - carrier diffusion - diffusion current density - total current density		3	1,6
1.9	The Hall effect		1	1,6
2.0	**The pn Junction and Fundamentals of Metal - Semiconductors**		**18**	
2.1	The pn junction - basic structure of the pn junction		1	2,6
2.2	Zero applied bias - built-in potential barrier		1	2,6
2.3	Electric field-space charge width - reverse applied bias -space charge width and electric field		1	2,6
2.4	Junction capacitance - one-sided junctions - Junction breakdown		1	2,6
2.5	The pn junction diode - pn junction current - qualitative description of charge flow in a pn junction		1	2,6
2.6	Ideal current - voltage relationship - boundary conditions - minority carrier distribution - ideal pn junction current - temperature effects		2	2,6
2.7	Fundamentals of MOSFET		1	2,6
2.8	The two-terminal MOS structure - energy band diagrams - depletion layer thickness - surface charge density - work function differences - threshold voltage	**18**	2	2,6
2.9	The basic MOSFET operation - MOSFET structures - current-voltage relationship - concepts - transconductance		2	2,6
2.10	The CMOS technology - the bipolar transistor - the basic principle of operation		1	2,6
2.11	Simplified transistor current rrelation - qualitative discussion - the modes of operation - amplification with bipolar transistors		2	2,6
2.12	The JFET - basic pn JFET operation - internal pinch-off voltage, pinch-off voltage and drain-to-source saturation voltage		2	2,6
2.13	Ideal dc current-voltage relationship - depletion mode JFET		1	2,6
3.0	**Optical Devices**		**14**	
3.1	Optical absorption - photon absorption coefficient		2	3,6
3.2	Solar cells - the pn junction solar cell - conversion efficiency and solar concentration		2	3,6
3.3	Photo detectors – photoconductor – photodiode - light emitting diodes - generation of light		4	3,6
3.4	Internal quantum efficiency - external quantum efficiency		2	3,6
3.5	Semiconductor microwave and power devices		2	3,6
3.6	Tunnel diode - GUNN diode		2	3,6
4.0	**Nanoscience and Introduction to Spintronics**		**22**	
4.1	Introduction to nanoelectronics		2	4,6
4.2	Single electron tunneling - single electron transistor	**36**	2	4,6
4.3	Molecular machines - molecular and nanoelectronics		2	4,6

4.4	Fuel cells - hydrogen storage		4	4,6
4.5	Photonic nanocrystals and integrated circuits - quantum computers		2	4,6
4.6	Quantum mechanics of spin - spin relaxation mechanisms		2	4,6
4.7	Spin dependent transport and tunnelling		2	4,6
4.8	Spin hall effect - silicon based spin electronic devices		2	4,6
4.9	Spin photo electronic devices - nano structures for spin electronics		2	4,6
4.10	Spintronic biosensors - spin transistors - quantum computing with spins		2	4,6

Books for Study

1. D. A. Neamen, Semiconductor Physics and Devices, 3^{rd} Edition, McGraw Hill (2003)
2. B. G. Streetman, Solid State Electronic Devices, 3^{rd} Edition, PHI Pvt. Ltd. (2000)
3. Charles Kittel, Introduction to Solid State Physics, John Wiley&Sons (2007)
4. Ashcroft and Mermin, Solid State Physics, Thomson Press Ltd. (2007)
5. M. Ali Omar, Elementary Solid State Physics: Principles and Applications, Addison-Wesley (2005)
6. M. A. Wahab, Solid State Physics-Structure and Properties of Materials, 2^{nd} Edition, Alpha Science International (2005)
7. S. O. Pillai, Solid State Physics, 6^{th} Edition, NewAge Science (2009)
8. S. M. Sze, Semiconductor Devices: Physics and Technology, 2^{nd} Edition, John Wiley & Sons (2002)
9. Sedra A. S. and Smith K. C., Microelectronic Circuits, 2^{nd} Edition, Holt, Rinehart and Winston (1987)
10. Ben G. Streetman and Sanjay K.Banerjee, Solid State Electronic Devices, Pearson Education (2002)
11. D. K. Roy, Physics of Semiconductor Devices,Universities Press (2002)
12. M. S. Tyagi, Introduction to Semiconductor Materials and Devices, John Wiley & Sons (2000)
13. M. F. Ashby, P. J. Ferreira, D. L. Schodek, Nanomaterials: Nanotechnologies and Design, Butterworth-Heinemann (2009)
14. C. P. Poole and F. J. Owens, Introduction to Nanotechnology, John Wiley & Sons (2007)
15. B. S. Murty, P. Shankar, Baldev Raj, B. B. Rath and James Murday ,Textbook of Nanoscience and Nanotechnology, Universities Press Pvt. Ltd. (2003)
16. Cornelius T. Leondes, MEMS/NEMS Handbook: Techniques and Applications, Volume1, Design Methods, Springer (2006)
17. S. Bandyopadhyay and M. Cahay, Introduction to Spintronics, 2^{nd} Edition, CRC Press (2008)
18. M. Johnson, Magnetoelectronics,1^{st} Edition, Academic Press (2004)
19. S. Maekawa, Concepts in Spin Electronics, Oxford University Press (2006)
20. D. D. Awschalom, R. A. Buhrman, J. M. Daughton, S. V. Molnar, and M. L. Roukes, Spin Electronics, Kluwer Academic Publishers(2004)
21. Y. B. Xu and S. M. Thompson, Spintronic Materials and Technology, Taylor & Francis, (2006)

Course Details	
Code	**APPY424.1**
Title	**Advanced Electronics - II**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/IV
Hrs/Week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Understand the principles behind the different types of Microprocessors and apply them to real life problems.	U, Ap	1,4
2	Understand the techniques like radar communication, satellite communication, etc.	U,R	1,4,5
3	Use microprocessor programming for solving real life problems	Ap	4
4	Idea using artificial intelligence for robotics	Ap,An	4,6
5	Analyse the methods of microprocessors, radars, etc.	Ap,An	4,6

PSO-Program specific outcome; CO-Course Outcome
Cognitive Level: R- Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	Course Description	Hrs	Hrs	CO No.
1.0	**Microprocessor 8086: Introduction and Programming**	**36**	**16**	
1.1	Internal architecture of 8086		2	1
1.2	Pin configuration of 8086		2	1
1.3	Memory organization of 8086 - addressing modes of 8086		2	1,2
1.4	Minimum and maximum mode configurations		2	6
1.5	Instructions set of 8086 - data movement instructions - arithmetic and logic instructions		2	1,2
1.6	Programming of 8086 - flow charts and programming steps - simple programs - one’s complement of a 16 bit number		2	2,3
1.7	BCD to ASCII - ASCII to BCD		2	1,2,3
1.8	Addition of 2-16 bit numbers		2	2
2.0	**Microprocessor Interfacing Devices and Advanced Microprocessors**		**16**	
2.1	Programmed I/O - direct memory access – microcontrollers - 8251A USART - 8257 DMA controller		4	1
2.2	8259A programmable interrupt controller - 8279 programmable key board/display interface - analog to digital and digital to analog converters		4	1

2.3	Advanced microprocessors 80186/80188 high integration 16-bit microprocessors		4	1,2
2.4	80386 and 80386 processors - RISC processors		4	6
3.0	**Elements of Embedded Systems**		**4**	
3.1	Example of an embedded system - processor chips for embedded applications		2	2,3
3.2	A simple micro controller using embedded systems		2	1,2,3
4.0	**Introduction to Artificial Intelligence and Expert Systems**	**36**	**16**	
4.1	Overview of artificial intelligence (AI)		1	1
4.2	Knowledge representation in AI-problem solving in AI		1	1
4.3	Search methods - predicate and propositional logic		2	1,2
4.4	Formal symbolic logic - LISP and PROLOG basics		2	6
4.5	Network representations of knowledge		2	1,2
4.6	Natural language study in AI - fuzzy sets and fuzzy logic		2	2,3
4.7	Expert systems - rule based expert systems		2	1,2,3
4.8	Non production system architectures		2	2
4.9	Examples of expert systems		2	1,2,3
5.0	**Artificial Neural Networks**		**20**	
5.1	Introduction to robotics		1	6
5.2	Artificial intelligence machines		1	1,2
5.3	Language based and knowledge based machines		2	2,3
5.4	Fuzzy expert systems - fuzzy quantifiers		2	1,2,3
5.5	Fuzzy inference - fuzzy rule based systems		2	2
5.6	Engineering applications of fuzzy logic		2	6
5.7	Applications in power plants, data mining and image processing and control instrumentation		2	1,2
5.8	Basic concepts of artificial neural networks		2	2,3
5.9	Neural network architectures		2	1,2,3
5.10	Learning methods - neural network systems		2	2
5.11	ADALINE and MADALINE networks - neural network application domains		2	2,3
6.0	**Radar**	**18**	**10**	
6.1	Basic principles of radar		2	6
6.2	Radar equation		2	1,2
6.3	MTI radars – pulse and doppler Radars		2	2,3
6.4	Radar signal analysis ideas of radar transmitters and receivers		2	1,2,3
6.5	Hyperbolic systems for navigation - LORAN and DECCA systems		2	2
7.0	**Satellite Communication**		**8**	
7.1	Satellite orbits		1	6
7.2	Geosynchronous satellites		1	1,2
7.3	Antenna look angles		1	2,3
7.4	Satellite classifications		1	1,2,3
7.5	Spacing and frequency allocations		1	2
7.6	Satellite antenna radiation patterns		1	6
7.7	Satellite system link models		1	1,2
7.8	Satellite system parameters		1	2,3

Books for Study

1. Sunil Mathur, Microprocessor 8086 - Architecture, Programming and Interfacing, PHI learning Pvt. Ltd. (2011)
2. Abishek Yadav, Microprocessor 8085, 8086, University Science Press, New Delhi (2008)
3. Carl Hamacher, Zvonko Vranesic and Safwat Zaky, Computer Organization, 5th Edition, McGraw Hill Education (2002).
4. B. Ram, Fundamentals of Microprocessors and Microcontrollers, Dhanpat Rai Publications, NewDelhi (2016).
5. Robert J. Schalkoff, Artificial Neural Networks, McGraw Hill Inc. (1997)
6. V. S. Janakiraman, K. Sarukesi and P. Gopalakrishnan, Foundations of Artificial Intelligence and Expert Systems, Laxmi Publications (2017)
7. E. Richand K. Knight, Artificial Intelligence, 2nd Edition, Tata McGraw Hill Education (2006)
8. D. W. Patterson, Introduction to Artificial Intelligence and Expert System, Prentise Hall of India Pvt. Ltd. (2001)
9. S. Rajasekharan and G. A. Vijalekshmi Pai, Neural Networks, Fuzzy logic and Genetic Algorithms: Synthesis and Applications, PHI learning Pvt. Ltd. (2011)
10. S. N. Sivanandam, S. Sumathiand and S. N. Deepa, Introduction to Fuzzy Logic using MATLAB, Springer (2007)
11. A.Veera Lakshmi and R. Srivel, Television and Video Engineering, Ane Books Pvt. Ltd. (2010)
12. Merrill I. Skolnik, Introducion to Radar Systems, 3rd Editon, Tata McGraw Hill (2001)
13. N. S. Nagaraja, Elements of Electronic Navigation, 2nd Edition, Tata McGraw Hill (2006)

Course Details	
Code	**APPY424.2**
Title	**Theoretical Physics - II**
Degree	M.Sc.
Branch	Physics
Year/Semester	2/IV
Hours/week	5
Total hours	90

CO No.	**Expected Course Outcomes** *Upon completion of this course, the students will be able to*:	**Cognitive Level**	**PSO No.**
1	Explain the concepts of advanced theoretical physics covering functional and path integrals in quantum mechanics, theory of many particle systems and critical phenomenon	U, R	1,3,6
2	Describe functional and path integrals in quantum mechanics	U, R	3,4
3	Apply the theory of broken symmetry and collective phenomenon to understand Bose Einstein condensation	U, Ap	3,5,6
4	Apply mean field theory to understand superfluidity and superconductors	Ap	3,5,6
5	Distinguish the different phase transitions and critical behaviour	An	3,6
6	Apply Ising model to understand magnetism	U, Ap	3,6

PSO – Program specific outcome; CO – Course outcome
Cognitive Level: R-Remember; U-Understanding; Ap-Apply; An-Analyze; E-Evaluate; C-Create

Module	**Course Description**	**Hrs**	**Hrs**	**CO No.**
1.0	**Functional Integrals in Physics**	**36**	**12**	
1.1	Function vs functional		3	1,2
1.2	Functional derivatives		3	1,2
1.3	Functional integration		3	1,2
1.4	Gaussian integrals		3	1,2
2.0	**Path integrals in quantum mechanics**		**24**	
2.1	Single particle systems - Feynman path integral		2	1,2
2.2	Propagator as a functional integral		2	1,2
2.3	Born approximation		2	1,2
2.4	Coulomb scattering		2	1,2
2.5	Many particle systems - second quantization		2	1,2
2.6	Coherent states and many - body path integrals		2	1,2
2.7	Field integral for the quantum partition function		2	1,2
2.8	Quantum fields - path integrals for fields		2	1,2
2.9	Functionals for bosonic and fermionic fields		2	1,2
2.10	Generating functions for free and interacting fields		2	1,2
2.11	Wick's theorem		2	1,2
2.12	Perturbation theory		2	1,2

3.0	**Many particle physics**	**36**	**20**	
3.1	Broken symmetry and collective phenomena - mean field theory		5	1,3
3.2	Bose-Einstein condensation and superfluidity		5	1,3
3.3	Superconductivity		5	1,3
3.4	Interacting electron gas and disorder		5	1,3
4.0	**Response functions**		**16**	
4.1	Linear response theory		5	1
4.2	Analytic structure of correlation functions		5	1
4.3	Electromagnetic linear response		6	1
5.0	**Critical phenomena**	**18**	**18**	
5.1	Continuous phase transitions		3	1,5
5.2	Critical behavior		3	1,5
5.3	Scaling		3	1
5.4	Renormalization group		3	1
5.5	Ising model		3	1,6
5.6	RG analysis of ferromagnetic transition		3	1,6

Books for Study

1. F. Scheck, Quantum Physics, Springer (2007)
2. G. Teschl, Mathematical Methods in Quantum Mechanics: With Applications to Schrodinger Operators, 2nd Edition, American Mathematical Society (2014)
3. P. Szekeres, Modern Mathematical Physics, Cambridge University Press (2004)
4. M. T. Vaughn, Introduction to Mathematical Physics, Wiley - VCH Verlag (2007)
5. G. B. Arfken, H. J. Weber and F. E. Harris, Mathematical Physics for Physicists, 7th Edition, Academic Press (2012)
6. J. J. Sakurai, Modern Quantum Mechanics, Addison-Wesley Publishing Company (1994)
7. L. I. Schiff, Quantum Mechanics, McGraw-Hill Book Co. (1968)
8. L. H. Ryder, Quantum Field Theory, Cambridge University Press (2008)
9. J. J. Sakurai, Advanced Quantum Mechanics, Addison-Wesley (1967)
10. M. Le Bellac, Quantum and Statistical Field Theory, Oxford University Press (2001)
11. K. Schulten and I. Kosztin, Lectures in Theoretical Biophysics, University of Illinois at Urbana-Champaign (2000)
12. R. Kubo, M. Toda and N. Hashitsume, Statistical Physics II: Non-equilibrium Statistical Mechanics, Springer-Verlag (1985)
13. G. F. Mazenko, Non equilibrium Statistical Mechanics, Wiley-VCH Verlag (2006)
14. V. Balakrishnan, Elements of Non equilibrium Statistical Mechanics, CRC Press (2008)
15. B. F. Schutz, A First course in General Relativity, Cambridge University Press (2009)
16. S. Caroll, Space time and Geometry: An Introduction to General Relativity, Addison-Wesley (2004)
17. A. Altland and B. Simons, Condensed Matter Field Theory, Cambridge University Press (2008)
18. J. W. Negele and H. Orland, Quantum Many-particle Systems, Levant Books (2006)
19. E. Fradkin, Field Theories of Condensed Matter Systems, Levant Books (2006)
20. P. M. Chaikin and T. C. Lubensky, Principles of Condensed Matter Physics, Cambridge University Press (2004)
21. A. M. Tsvelik, Quantum Field Theory in Condensed Matter Physics, Cambridge University Press (2003)
22. R. Shankar, Principles of Quantum Mechanics, Springer (1994)
23. L. E. Ballentine, Quantum Mechanics, World Scientific Publishing Co. (2000)

APPY2P1 GENERAL PHYSICS PRACTICAL

(Total of 10 experiments to be done from Section A and B)

Section A (*at least 5 experiments to be done in this section*)

1. Determination of elastic constants by Cornu's method *(elliptical and hyperbolic fringes)*
2. Analysis of absorption spectra of liquids using spectrometer
3. Study of ultrasonic waves in liquids
4. Determination of e/k using Ge and Si transistors
5. Anderson Bridge –determination of self and mutual inductance
6. Michelson Interferometer experiments
7. Identification of Fraunhofer lines in solar spectra
8. Verification of Richardson's equation using diode valve
9. LED experiments (a) wavelength determination (b) I-V characteristics (c) output power variations with applied voltage etc.
10. Thermal diffusivity of brass

Section B *(at least 2 experiments to be done from this section)*

1. BH curve-anchor ring
2. Study of photoelectric effect and determination of of Planck's constant
3. Determination of Stefan's constant
4. Experiments using Laser:
   (a) Laser beam characteristics (b) Diffraction grating (c) Diffraction at different types of slits and apertures (d) refractive index of liquids (e) particle size determination
5. Young's modulus of different materials using strain gauge
6. Determination of magnetic force in a current carrying conductor
7. Optical fibre characteristics – numerical aperture, attenuation and bandwidth of given specimen
8. Variation of dielectric constant with temperature of ferroelectric material
9. Dielectric constant of non-polar liquid.
10. Cauchy's constants of liquids and liquid mixtures using hollow prism and spectrometer
11. Surface tension of a liquid using Jaeger's method
12. Experiments using Phoenix Kit
    (a) Capacitor charging/discharging experiments (b) Dielectric constant of glass

APPY2P2 ELECTRONICS AND COMPUTATIONAL PHYSICS PRACTICAL

Unit I - Electronics Experiments *(A total of **ten** experiments to be done)*

Section A (*A minimum of **five** experiments to be done*)

1. Single stage CE amplifier –Design and study of frequency response
2. Study of RC Phase shift oscillator circuits using Transistors
3. Construction and study of astable multivibrator and VCO circuits using Transistors
4. Study of OP Amp circuits (a) summing amplifier (b)difference amplifier
5. OP Amp as an integrator and differentiator
6. Characteristics of JFET and MOSFET
7. Characteristics of SCR
8. Design and study of negative feedback amplifier circuits
9. Study of Clipping and Clamping circuits
10. UJT Characteristics and UJT relaxation Oscillator

Section B *(A minimum of **three** experiments to be done)*

1. Emitter follower and source follower circuits
2. Weinberg oscillator using OP Amp
3. SR and JK Flip Flops -construction using Logic Gates and study of truth tables
4. Study of the frequency response of a tuned amplifier
5. Study of power amplifier circuits
6. Frequency multiplier using PLL
7. Study of Schmitt trigger circuits using transistors
8. Construction and study of cascade amplifier circuit using transistors.
9. Simple electronics experiments using Phoenix and Python based Kits.

Unit - II Computer Programming
(*A minimum of **eight** experiments to be done, programs should be written in C++ language*)

1. Least square fitting
2. First derivative of tabulated function by difference table
3. Numerical integration (Trapezoidal rule and Simpson method)
4. Solution of algebraic and transcendental equations using Newton-Ralphson method
5. Solution of algebraic equations using bisection method
6. Numerical interpolation using Newton and Lagrangian methods
7. Monte Carlo simulation
8. Evaluation of Bessel and Legendre functions
9. Matrix addition, multiplication, trace, transpose and inverse.
10. Fourier series analysis
11. Study of motion of projectile in a central force field
12. Study of Planetary motion and Kepler's laws

APPY4P1 ADVANCED PHYSICS PRACTICAL

Unit I - Physics Experiments (*A total of* ***ten*** *experiments to be done*)

Section A *(A minimum of* ***five*** *experiments to be done)*

1. e/m of an electron - Thompson's method
2. Charge of an electron - Millikan's method
3. Determination of Fermi energy of copper
4. Study of variation of resistance of a semiconductor with temperature and determination of band gap
5. Magnetic susceptibility of a liquid using Quincke's method
6. Ferromagnetic studies using Guoy's method
7. Hall effect in a semiconductor
8. Rydberg constant determination using grating, spectrometer and discharge tubes
9. Thermo-emf of bulk samples, like, Al, Cu, Brass etc.
10. Zeeman effect using Fabry-Perot Interferometer

Section B (*A minimum of* ***two*** *experiments to be done*)

1. Electrical characteristics of a solar cell
2. Studies using UV visible spectrophotometer
3. Refractive index of liquids and liquid mixtures using Abbe's refractometer
4. Optical activity studies using polarimeters
5. Determination of temperature characteristics of a flame
   (a) Candle flame using digital photography and image analysis
   (b) Sodium flame in comparison with incandescent lamp using a spectrometer
6. LDR and photodiode characteristics
7. Simple experiments using GM counter
8. Determination of dielectric constant of materials
9. Experimental determination of Avogadro's number using an electrochemical cell
10. Study of arc spectra and hydrogen spectra using an imager (CCD) and photo electric/electronic recorder

Unit II – Data Analysis *(A minimum of* ***five*** *experiments to be done)*

1. Analysis of the given band spectrum
2. Analysis of given rotation-vibration spectrum
3. Interpretation of vibration spectra of simple molecules using Raman and IR spectra
4. Dissociation energy of diatomic molecules
5. Analysis of powder XRD data
6. Study of stellar spectral classification from low dispersion stellar spectra
7. Study of HR diagram of stars
8. Radioactive material counting statistics
9. Interpretation of UV- visible spectra of materials
10. Weather and astronomy related image processing

APPY4P2 ADVANCED ELECTRONICS PRACTICAL

Unit I - Electronics Experiment (*A total of* ***seven*** *experiments to be done***)**

Section A (*A minimum of* ***five*** *experiments to be done***)**

1. Study of active filters using OP amps (a) low pass (b) high pass (c) band pass for both first order and second order-gain/ roll off determination
2. Wave form generation using OP amp circuits:
   (a) astable and monostable multivibrators (b) square, triangular and saw-tooth wave generation
3. IC 555 timer experiments (a) monsostable and astable multivibrators (b) VCO
4. D/A convertor circuits using OPAMP 741
5. Differential amplifier circuits using transistors
6. Design of series pass voltage regulators using (a) transistors with load and line regulation (b) OPAMP

Section B *(A minimum of* ***two*** *experiments to be done)*

1. Study of IF tuned amplifier and amplitude modulation (generation and detection) using transistor, diode, etc.
2. Frequency modulator and detector circuits.
3. Pulse modulation circuits using 555 timer (a) PAM (b) PWM
4. Digital modulation circuits (a) BFSK generation using 555 timer (b) BFSK detector using 555 timer and PLL (c) BPSK generation
5. Shift register and ring counter circuits using flip flops
6. Miscellaneous transistor applications (a) automatic night light with LDR
   (b) inverter circuit (transistors as a switch) (c) time delay circuit using SCR
7. BCD to decimal decoder and seven segment display using IC
8. Design of electronic counters (up and down counters)

Unit II – Microprocessor Experiments *(A minimum of* ***five*** *experiments to be done)*

1. 8086 program to find out largest from a group of 8bit/16 bit numbers
2. Square wave generation using 8255 interface with 8086
3. 8086 program for block additions
4. Interfacing LED display board with 8086
5. 8086 program to convert binary to ASCII and ASCII to BCD
6. 8086 program to arrange a given data in ascending and descending order
7. 8086 simple traffic light controller
8. 8086 program for binary to BCD conversion and vice versa
9. Program of Fibonacci series using 8086